VOLUME VII MARCH 1924 NUMBER 2

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

Contents

Reading the Fat in Cream Tests—GEORGE SPITZER AND W. F. EPPLE 131
First American World's Dairy Congress a Success—J. H. FRANDSEN 138
The Effect of Storage on the Peroxidase Activity of Whole Milk Powders—C. D. DAHLE AND L. S. PALMER 141
The Color of Cow's Milk and Its Value—F. J. DOAN 147
True Protein Versus Crude Protein as a Basis for Computation of Feeding Standards—E. B. FORBES 154
Studies in the Growth and Nutrition of Dairy Calves. X. Self-Feeding a Grain Mixture to Young Calves—ANDREW C. MCCANDLISH 160
Associative Action as a Cause of Yellow Color in Yeast Colonies—B. W. HAMMER 163
Variations in Amount of Milk and Percent of Fat in the Milk from Different Quarters of the Cow's Udder—J. B. FITCH AND LYNN COPELAND 169
The Viscosity of Natural and Remade Milk—OSCAR L. EVENSON AND LESLIE W. FERRIS 174
The Relation Between Age and Fat Production in Dairy Cows—ARTHUR C. RAGSDALE, CHARLES W. TURNER AND SAMUEL BRODY 189
The Effect of Milk Plant Operations on the Amount of Cream Rising on Milk—W. H. MARTIN AND W. B. COMBS 197
Dairy Notes 205
Review of Dairy Literature 210

PUBLISHED BI-MONTHLY
WILLIAMS & WILKINS COMPANY
BALTIMORE, U. S. A.
Copyright, 1924, by Williams & Wilkins Company

Made in United States of America

The Cherry Twin Coil in Pasteurization

In addition to the fact that the Cherry Milk Pasteurizer is the best built, best insulated and most scientifically engineered machine of its kind ever built, it has the added advantage of being equipped with the

Cherry Twin Coil

Two independent streams of the heating or cooling liquid pass through this coil. Each stream goes through a separate coil, giving practically double the flow found in other types of coils. This means there is no "cold" end of the coil and that the batch temperature is uniform **throughout.**

Do not confuse the Cherry patented Twin Coil with ordinary "double" coils or with coils in which the liquid passes from end to end and back again through alternate coils.

What This Coil Does

It speeds up output by bringing batch to desired temperature in less time.
It brings ALL the batch to the same temperature.
It permits holding temperatures more positively.
Where cooling is done in the pasteurizer it enables the operator to do the work faster than is possible with any other coil.
It gives a larger output from the same size vat in which a single coil or imitation coil is used.

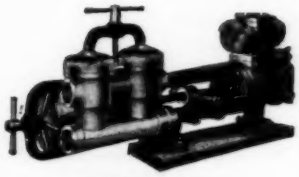
Send for Bulletin No. 2031 giving specifications on all Cherry Coil Machines.

J.G. CHERRY COMPANY

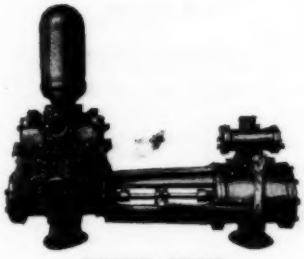
ST. PAUL MINN. — TAMA IOWA — PEORIA ILL.
CEDAR RAPIDS
IOWA

"DAVIDSON" PUMPS

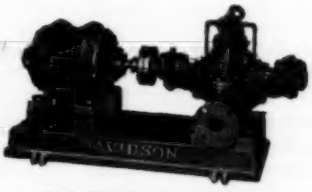
for Creameries and Milk Plants



MILK PUMP



WATER PUMP



CENTRIFUGAL PUMP

MILK PUMPS

BOILER-FEED PUMPS

BRINE-CIRCULATING PUMPS

TANK SUPPLY PUMPS

WASHER PUMPS

ARTESIAN WELL PUMPS

Strict adherence for more than 40 years to our policy of high grade materials and first-class workmanship have produced "The Best Pump Built"

Send for Catalog and References in Your Vicinity

M. T. DAVIDSON COMPANY

154 Nassau Street, New York

135 Oliver St., Boston, Mass.
1011 Chestnut St., Philadelphia, Pa.
1224 Granite Building, Rochester, N. Y.
504 Empire Building, Detroit, Mich.
817 Albee Building, Washington, D. C.
37 W. Van Buren Street, Chicago, Ill.

Your advertisement is being read in every State and in 25 Foreign Countries

JOURNAL
OF
DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

J. H. FRANDSEN, Editor
Lincoln, Nebraska

ASSOCIATE EDITORS

F. W. BOUSKA, Chicago, Ill.
A. A. BORLAND, State College, Pa.
C. H. ECKLES, St. Paul, Minn.
R. C. FISHER, Storrs, Conn.
J. B. FITCH, Manhattan, Kans.
J. A. GAMBLE, College Park, Md.
E. S. GUTHRIE, Ithaca, N. Y.
H. A. HARDING, Detroit, Mich.
S. H. HARVEY, College Park, Md.
O. F. HUNZIKER, Chicago, Ill.
H. H. KILDEE, Ames, Iowa
C. W. LARSON, Washington, D. C.
W. B. P. LOCKWOOD, Amherst, Mass.
M. MORTENSEN, Ames, Iowa
LEROY S. PALMER, St. Paul, Minn.
T. R. PIRTLE, Washington, D. C.
C. L. ROADHOUSE, Davis, Calif.
L. A. ROGERS, Washington, D. C.
H. A. RUEHE, Urbana, Ill.
W. A. STOCKING, JR., Ithaca, N. Y.
H. E. VAN NORMAN, Washington, D. C.
IVAN C. WELD, Washington, D. C.
G. C. WHITE, Storrs, Conn.

OFFICERS OF AMERICAN DAIRY SCIENCE ASSOCIATION

President ..... A. A. BORLAND, State College, Pennsylvania
Vice President ..... O. E. REED, East Lansing, Michigan
Secretary-Treasurer ..... J. B. FITCH, Manhattan, Kansas

SECTION NO. 1—DAIRY PRODUCTION

Chairman ..... J. J. HOOPER, Lexington, Ky.
Secretary ..... J. A. GAMBLE, College Park, Md.

SECTION NO. 2—DAIRY MANUFACTURES

Chairman ..... H. W. GREGORY, Lafayette, Ind.
Secretary ..... R. C. FISHER, Storrs, Conn.

SECTION NO. 3—EXTENSION

Chairman ..... L. W. MORLEY, State College, Pa.
Secretary ..... C. A. HUTTON, Knoxville, Tenn.

SECTION NO. 4—OFFICIAL TESTING

Chairman ..... R. T. HARRIS, Madison, Wis.
Secretary ..... G. C. WHITE, Storrs, Conn.

Your advertisement is being read in every State and in 25 Foreign Countries

HERE IT IS---

The Book That Bacteriologists Have Been Waiting For

BERGEY'S MANUAL

OF

DETERMINATIVE BACTERIOLOGY

By The Committee on Determinative Bacteriology of the Society of American Bacteriologists

Under the Chairmanship of David H. Bergey, Laboratory of Hygiene, University of Pennsylvania, Philadelphia, Pa.

THE OTHER MEMBERS OF THE COMMITTEE ARE:

Francis C. Harrison, McDonald College, P. Q., Canada
Robert S. Breed, New York Agricultural College, Geneva, N. Y.
Bernard W. Hammer, Iowa Agricultural College, Ames, Iowa
Frank M. Huntoon, Glenolden, Pa.

This Book Will Be of Valuable Assistance in Standardizing Determinative Bacteriology Work and in Aiding the Identification of Cultures of Unknown Organisms

OF SPECIAL INTEREST TO

LABORATORY WORKERS engaged in practical Bacteriological work
TEACHERS of Bacteriology and related sciences
STUDENTS of Bacteriology in all of its phases
MEDICAL MEN will find it very valuable in diagnostic work in determining pathogenic species
OTHERS interested in Bacteriology, both theoretical and applied

PUBLICATION DATE---AUGUST 1923

PRICE, NET POSTPAID { $5.50 UNITED STATES, CANADA, MEXICO, CUBA / $5.75 OTHER COUNTRIES

Royalties from the sale of the Manual are credited to the Society of American Bacteriologists and accumulated in a separate fund to stimulate further work in this field

---

WILLIAMS & WILKINS COMPANY
PUBLISHERS OF SCIENTIFIC BOOKS AND JOURNALS
MOUNT ROYAL AND GUILFORD AVES.,
BALTIMORE, MARYLAND., U.S.A.

GENTLEMEN:

Kindly send ON FIVE DAYS APPROVAL one copy of BERGEY'S MANUAL OF DETERMINATIVE BACTERIOLOGY by the Committee on Classification (Francis C. Harrison, Robert S. Breed, Bernard W. Hammer, Frank M. Huntoon, David H. Bergey, Chairman), of the Society of American Bacteriologists. If I keep the book, I will remit promptly on receipt of your statement. Otherwise, I will return it promptly, postage prepaid.

$5.50, United States, Canada, Mexico, Cuba.
$5.75, all other countries. (Orders from outside the United States and Canada must be accompanied by remittance which will be refunded immediately if the book is returned.)

Name_____

Address_____ M.D.B.F-1

Your advertisement is being read in every State and in 25 Foreign Countries

MILK, CREAM, BUTTER TESTING

QUICK **SIMPLIFIED** **ACCURATE**

MONEY SAVING

Test Tube

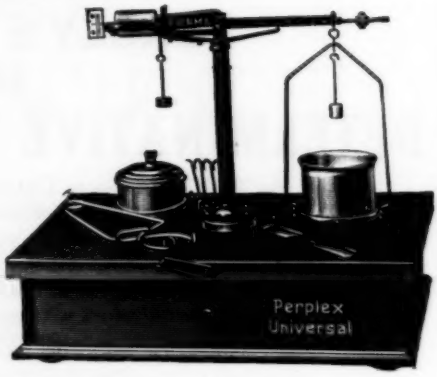
Other Specialties:

Test of Condensed-Dried-Milk, Cheese

Ice Cream by the New Troy-Fucoma Method

Methylene Blue Test
Catalase Test

Complete line of most accurate Thermometers, Lactometers, etc.



Butter Moisture Scale

FUCOMA COMPANY, Inc.

154 NASSAU STREET NEW YORK

Laboratory Supplies For Dairies, Creameries, Butter and Cheese Factories. Write For Our Illustrated Circulars

AUTHORITATIVE BOOKS

Carriers in Infectious Diseases (Nichols)	$3.50
The Bacteriophage—Its Rôle in Immunity (d'Hérelle). Authorized Amer. Ed.	4.00
The Determination of Hydrogen Ions (Clark) 2nd ed. Reprinted June, 1923	5.00
The Vitamine Manual (Eddy) Foreign, $2.75	2.50
The Vitamines (Funk) 2nd ed.	5.50
The Heart Rhythms (Lamson). Foreign, $2.60	2.50
Origin and Evolution of the Human Dentition (Gregory)	8.50
The Emotions (James-Lange)	3.50
Dictionary of Botanical Equivalents (Artschwager and Smiley). Foreign, $2.25	2.00
Eugenics, Genetics and the Family. Foreign, $6.00	6.00
Eugenics in Race and State. Foreign, $6.00	6.00
Exhibits Book of the Second International Exhibition of Eugenics. Foreign, $3.00	3.00
Chemistry of Tuberculosis (Wells)	5.00
Bacteriology (Conn)	4.00
Rest and Other Things (Krause). Foreign, $1.60	1.50
Environment and Resistance in Tuberculosis (Krause). Foreign, $1.60	1.50
Job Analysis and the Curriculum (Strong and Uhrbrock)	2.00 cloth / 1.00 paper
Tubercle Bacillus Infection and Tuberculosis in Man and Animals (Calmette). Amer. Ed.	8.00
The Tuberculosis Worker (Jacobs)	3.00
Bergey's Manual of Determinative Bacteriology. Foreign, $5.75	5.50
The Therapeutic Use of Digitalis. (Robinson). Foreign, $2.75	2.50
Cyanosis (Lundsgaard and Van Slyke). Foreign, $2.25	2.00
Tree Ancestors (Berry)	3.00
Weather Proverbs and Paradoxes (Humphreys). Foreign, $1.75	1.50

Prices are for United States, Canada, Mexico, Cuba Other Countries, add 50 cents, unless otherwise noted

Williams & Wilkins Company, Baltimore, Md., U. S. A.

New Books
on

Tuberculosis

A complete reference library which, in the light of present day knowledge, answers every question on tuberculosis problems.

Rest and Other Things. Allen K. Krause, M.D. $1.50

Environment and Resistance. Allen K. Krause, M.D. 1.50

Tubercle Bacillus Infection and Tuberculosis in Man and Animals. Albert Calmette, Pasteur Institute, Paris 8.00

Chemistry of Tuberculosis. Wells-DeWitt-Long 5.00

The Tuberculosis Worker. Philip P. Jacobs, Ph.D 3.00

ORDER FROM THE PUBLISHERS

WILLIAMS & WILKINS CO.

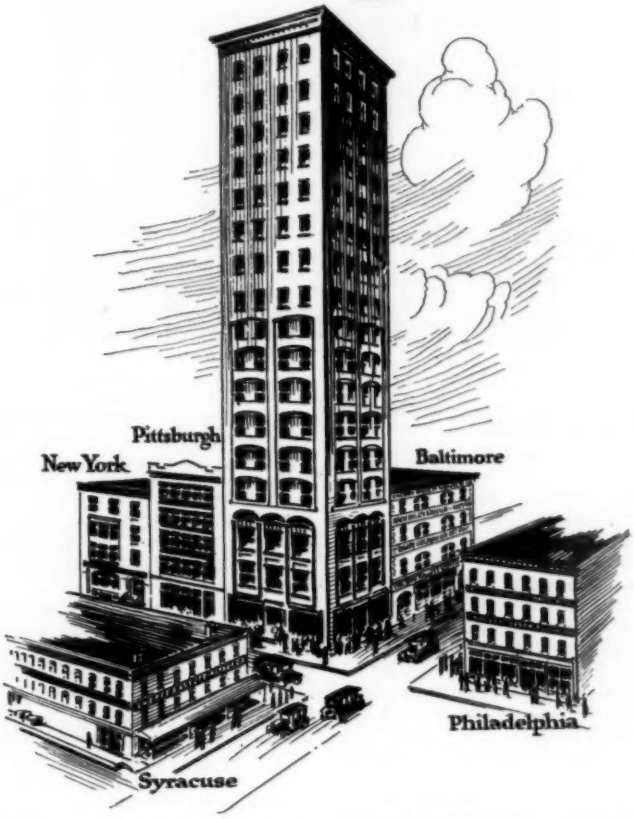
Publishers of Scientific Books and Journals

BALTIMORE, MARYLAND

Your advertisemenr is being read in every State and in 25 Foreign Countries

THE BESTOV CALENDAR

Complete Equipment to Handle Milk — from Cow to Consumer



One Hundred Thousand Square Feet of Floor Space Filled With Stock!

The five big stores of Cherry-Bassett-Winner Company total 100,000 square feet of floor space. If these five establishments could be brought together into a single massive building the result would be a skyscraper such as the artist has drawn, for he has calculated the equivalent in area of the five stores (shown as surrounding buildings) when creating this composite imaginary structure.

Think of such a building filled on every floor with machinery and supplies for the milk products industries and you have an idea of the resources of the Cherry-Bassett-Winner Company. This immense stock is divided and located at five convenient shipping points—Philadelphia, Baltimore, Pittsburgh, New York, Syracuse.

This is one reason why it pays to be a "Bestov" customer.

Your advertisement is being read in every State and in 25 Foreign Countries

JOURNAL

of

DAIRY SCIENCE

IMPORTANT ARTICLES THAT APPEARED IN 1923

Utilization of Buttermilk in the Form of Condensed and Dried Buttermilk. Hunziker.

Class Leaders in Agricultural College Herds. Davis and Braun.

The Mineral Requirements of Dairy Cows. Meigs.

The Relation Between Skin Color and Fat Production in Dairy Cows. Palmer.

Dairying in Vermont in the '70's and '80's. Hills.

The Alcohol Test as a Means of Detecting Abnormal Milk. Weimar.

Acidity of Butter and Its By-Products. Bouska.

A Ropy Milk Organism Isolated from the Finnish "Piima" or "Fiili." Macy.

The Colostrum Problem and Its Solution. Ragsdale and Brody.

A Study of Determining Solids-Not-Fat in Cow's Milk. Masurovsky.

Extension Activities and Their Relation to the College and Experiment Station. Borland.

A Study of the Factors That Influence the Coagulation of Milk in the Alcohol Test. Sommer and Binney.

Seasonal Variations in Milk and Fat Production. Turner.

A Study of the Use of Superheated and Unsuperated Plain Condensed Bulk Skim Milk in the Manufacture of Ice Cream. Tracy.

The Nutritive Value of Coconut Meal, Soy Beans, Rice Bran and Corn. Mitchell and Villegas.

Effect of Autoclaving on Vitamine Content of Milk. Slanetz.

Effects of Underfeeding on Milk Secretion. Ragsdale and Turner.

Copper in Dairy Products and Its Solution in Milk under Various Conditions. Rice and Miscali.

Some Factors Influencing Quality in Gelatin and the Use of the Fermentation Test as an Index of Bacterial Contamination. Parfitt.

Factors Influencing Two-Day Official Butter-Fat Tests of Cows. Wylie.

A Test for Determining the Character of Curd from Cows' Milk and Its Application to the Study of Curd Variance as an Index of the Food Value of Milk for Infants. Hill.

How the Advance of the Period of Lactation Affects the Milk Flow. Turner, Ragsdale, and Brody.

Sweetened Condensed Milk. I. Bacterial Thickening. Rice and Downs.

A Comparison of the Babcock and the Roese-Gottlieb (Mojonnier) Methods for Determination of Butterfat in Milk. Phillips.

The Relationships of Concentration and Time to the Temperature of Coagulation of Evaporated Skim and Whole Milk. Holm, Deysher, and Evans.

The Value of Milk Inspection for a Small City. Parfitt.

The Acidity Phase of the Ice Cream Mix. Masurovsky.

The Problem of Transporting Milk in a Hot Condition. Ayers and Johnson.

The Wide Distribution of Ropy Milk Organisms in City Milk Supplies. Ward.

The Production of Volatile Fatty Acids and Carbon Dioxide by Proprionic Acid Bacteria with Special Reference to Their Action in Cheese. Shaw and Sherman.

The Determination of Fat in Buttermilk. Tracey and Overman.

Comparison of Methods of Reading Cream Tests. Doan, Fields, and England.

The Relation of Oxidizability Value And the Amino and Ammonia Nitrogen Content to the Quality of Cream and Butter. Ferris.

A Study of the Action of Certain Bacteria, Yeasts and Molds on the Keeping Quality of Butter in Cold Storage. Grimes.

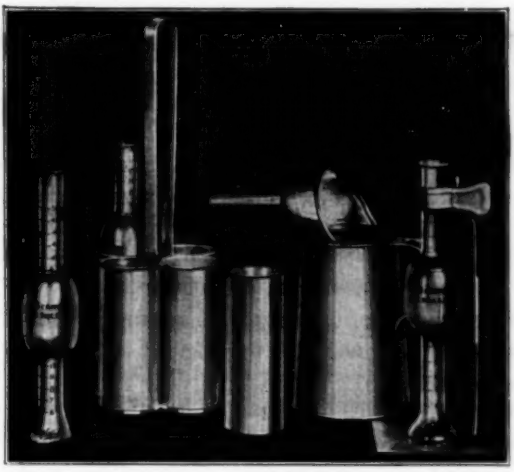
A Study of the Relation of the Composition of the Mix to Quality of the Finished Ice Cream. Ambrose.

A Greenish-Black Discoloration of Chocolate Ice Cream. Dahlberg.

Factors Influencing the Percentage of Fat in Milk. Woodward.

A System of Rearing Dairy Calves With Limited Use of Milk. Maynard and Norris.

Your advertisement is being read in every State and in 25 Foreign Countries



Maintain Uniformity of Your Butter

BY USING THE

Farrington Test for Fat in Butter

An accurate, economical, simple test for practical creamerymen.

Butter fat of samples may be saved as no sulphuric acid or other chemical is used.

Requires little extra time or equipment than that used for the Babcock and moisture tests.

DIRECTIONS SENT WITH TESTS OR UPON REQUEST

Sole licensed manufacturers of Farrington Test Bottles

LOUIS F. NAFIS, Inc.

Manufacturers of Scientific Glass Apparatus for Testing Milk and Its Products

17-23 North Desplaines St. **CHICAGO**

ASK THE MEN WHO USE IT

Your advertisement is being read in every State and in 25 Foreign Countries

The Growing Popularity of a Reliable Hypochlorite

The demand for B-K has followed a steady upward trend each year for the past twelve, since it was introduced.

Farmers who heretofore made only half hearted attempts at highly sanitary conditions, now take pride in low bacteria count and purified equipment. Creamerymen and small milk bottlers are likewise taking a new interest in producing a purer product.

The reason for this change is apparent. Without expensive equipment the attainment of sanitary conditions on the farm and in many creameries used to be an impractical dream. It is now a reality within the reach of all.

After 12 years of educational work, dairymen now know that chemical sterilization with B-K is easy, practical and so cheap to use that none can afford to be without it.

Every bottle of B-K is of known strength. Dairymen can get a uniform degree of sterilization by simply following directions. The facilities of our laboratories and research organizations are theirs for the asking. Every recommendation we make for the use of B-K is based upon ample tests showing effective results.

Chemical Purification with B-K has come to stay. Results speak louder than any amount of theorizing. B-K users are passing the message. Our daily mails are loaded with inquiries from leading farmers and manufacturers of dairy products about their various problems of Sanitation.

We invite correspondence with Mr. W. A. Hadfield, B.S., M.S., our chief chemist.

GENERAL LABORATORIES

Madison, Wisconsin

Your advertisement is being read in every State and in 25 Foreign Countries

READING THE FAT IN CREAM TESTS

GEORGE SPITZER AND W. F. EPPLE

Purdue University Agricultural Experiment Station, Department of Dairy Husbandry, Lafayette, Indiana

Received for publication November 12, 1923

Owing to the recent criticisms and misunderstanding concerning the manner of reading the test in the Babcock method for cream testing, we deemed it advisable to give a brief review and offer some additional data. It is not our intention to propose any modifications, but rather to substantiate and verify the accuracy of cream testing as compared with the official Roes-Gottlieb method for fat determinations.

The question of inconsistant results obtained by the Babcock method for cream testing when compared with the gravimetric method, has been the cause of numerous publications proposing modifications which should give most concordant results.

In 1903–1904, Ed. H. Webster, Bureau of Animal Industry, Bulletin No. 58, made a study of the testing of cream. The subject matter of this investigation which concerns this article, is his work and results on the value or per cent of butter fat included in the meniscus in cream testing.

Webster in his investigation found the value of the meniscus when compared with gravimetric method as shown in the following table:

Summary of average difference between extraction and Babcock methods

	TYPE OF TEST BOTTLE		
	30 per cent 9 inch, 9 grams	50 per cent 9 inch, 18 grams	50 per cent 6 inch, 18 grams
Reading to top of meniscus	+0.62	+0.62	+1.00
Reading to middle of meniscus	+0.22	+0.19	+0.43
Reading to bottom of meniscus	−0.19	−0.21	−0.12
Value of total meniscus or per cent	+0.81	+0.83	+1.12

\+ Per cent higher than that obtained by the extraction method.
− Per cent lower than that obtained by the extraction method.

The table represents the average of seven lots of cream. It will be seen that neither readings, to top, middle or bottom of meniscus, gives the true per cent of butter fat. If we examine the table from which the foregoing averages were obtained, we find that the greatest variation from the gravimetric extraction method by reading to the top of the meniscus, was for:

9 grams, 30 per cent, 9 inch	0.79 per cent
18 grams, 50 per cent, 9 inch	0.88 per cent
18 grams, 50 per cent, 6 inch	1.53 per cent

The readings of the test reported by Webster were made by a trained chemist. No doubt a still greater variation in reading would have occurred had the reading been made by the ordinary cream tester. The method, proposed by Webster in 1904, was never generally used.

In 1908–1909, Eckles, at that time Chief of the Dairy Husbandry Department of the Missouri Agricultural Experiment Station, proposed the use of amyl alcohol to eliminate the meniscus in reading the Babcock test for fat in cream. This was at least suggestive though it was never generally adopted for the reasons that amyl alcohol dissolves butter fat and being miscible with water, gave low readings, and the vapor of amyl alcohol is unpleasant and in excess may act as a poison.

About the same time, the Wisconsin Agricultural Experiment Station suggested the use of fat saturated ethyl alcohol to eliminate the meniscus. This modification was an improvement over amyl alcohol and was quite generally used. This modification also had its objectionable features, mainly the alcohol was saturated with butter fat at room temperature and when coming in contact with the warm fat column (135-140°F.) in the Babcock bottle, dissolved some of the fat and not infrequently a cloudy zone was produced at the juncture of alcohol and butter fat, which interfered with accurate readings. The foregoing substances were highly suggestive of a possibility of finding a substance which would eliminate the meniscus and give accurate readings and free from the objectionable features of amyl alcohol and fat saturated ethyl alcohol.

In 1909–1910, Professor O. F. Hunziker, at that time chief of the Dairy Husbandry Department, Purdue University, outlined and conducted with his assistants, an unexhaustive investigation on the subject of cream testing by the Babcock method, Bulletin 145, Purdue University Agricultural Experiment Station.

The following table taken from Bulletin 145, gives the reading of the meniscus of 355 samples of cream.

TABLE 1

*Showing reading to bottom and to top of the meniscus, per cent, meniscus and gravimetric fat estimation**

SAMPLE NUMBER	NUMBER OF TESTS	READING THE FAT COLUMN		MENISCUS	GRAVIMETRIC FAT ESTIMATION
		To top of the meniscus	To bottom of the meniscus		
		per cent	*per cent*	*per cent*	*per cent*
1	16	16.62	15.62	1.00	15.90
2	36	26.61	25.58	1.03	26.37
3	40	21.42	20.42	1.00	20.95
4	39	13.38	12.38	1.00	12.86
5	40	18.43	17.59	0.84	17.65
6	18	21.00	20.50	0.50	20.10
7	40	13.29	12.29	1.00	12.41
8	24	21.96	20.96	1.00	21.14
9	11	25.93	24.90	1.03	26.18
10	11	25.29	24.29	1.00	24.52
11	35	30.50	29.50	1.00	29.85
12	21	29.96	28.96	1.00	29.40
13	24	39.65	38.23	1.42	38.40
Average.....		23.38	22.40	0.99	22.75
Total number of tests.....	355				

* Bulletin 145, Purdue University Agricultural Experiment Station, 1910, p. 582.

The results of this investigation as shown in table 1 on the value of the meniscus which to a great extent corroborate the results obtained by Webster. In the foregoing tests the 6 inch 9 gram 50 per cent cream test bottle was used. The lowest value of the meniscus for the average of 18 samples was 0.50 per cent. The highest value of the meniscus for the average of 24

samples of cream tested, was 1.42 per cent. The average value for 355 tests was 0.99 per cent.

From table 1 it will be seen that there is a great variation in the value of the meniscus when read under uniform conditions.

TABLE 2

*Showing a comparison of glymol readings with the results of the gravimetric fat estimations**

SAMPLE NUMBER	NUMBER OF TESTS	GLYMOL READING	GRAVIMETRIC FAT ESTIMATION	DIFFERENCE
1	11	40.62	40.31	+0.31
2	12	34.30	34.06	+0.24
3	12	31.65	31.71	−0.06
4	12	29.87	29.61	+0.26
5	11	45.02	44.80	+0.22
6	12	28.83	29.04	−0.21
7	12	27.65	27.48	+0.17
8	12	19.24	19.47	−0.23
9	12	20.04	20.00	+0.04
10	12	19.00	18.88	+0.12
11	6	32.62	32.29	+0.33
12	12	35.78	35.96	−0.18
13	12	17.46	17.61	−0.15
14	12	43.83	43.77	+0.06
15	12	39.76	39.62	+0.14
16	12	40.73	40.73	0.00
17	12	27.76	27.89	−0.13
18	12	21.56	21.72	−0.16
19	11	38.37	38.22	+0.15
20	9	19.87	20.06	−0.19
21	10	16.53	16.80	−0.27
22	12	20.85	20.83	+0.02
Average.....		29.66	29.584	0.02
Total number of tests.....	248			

* The above data were taken from Bulletin 145, Purdue Agricultural Experiment Station.

This showed that the principle defects of the Babcock method for cream testing was in the uncertainty of the reading of the fat column. These results suggested the desirability of using some liquid which would eliminate the meniscus and give concordant and accurate tests. During the preliminary experiments

various mixtures of hydrocarbon oils were tried. It was at this time when white mineral oil or glymol[1] was first used to eliminate the meniscus in the Babcock test. After being convinced of its superiority of any liquid which had been tried, 248 samples of cream were tested by the use of glymol. Also a gravimetric determination was made for fat of each sample. The method used for fat extraction was the paper coil method which was the official method in 1910. Detailed results of the experiment are shown in table 2.

Inasmuch as the cream tests in tables 1 and 2 were made by the authors of Bulletin 145, who used more than ordinary precautions, we deemed it desirable for this article to secure additional data on cream testing. This data to be secured under the usual creamery routine practice. The tester was not aware of the purpose for which the tests were to be used. The fat in the samples of cream used for these tests was determined by the Roese-Gottlieb method. These results are shown in table 3.

From the work of this station, as well as the work of other investigators, there is no question but that the meniscus is the principle cause of the inaccuracy. There are reasons why reading the meniscus, either to the top or bottom and making proper allowances, cannot give accurate results. First, the meniscus is very seldom well defined; second the effect of light, whether reflected or transmitted; third, the angle at which the test bottle is held affects the reading of the meniscus. Only under exceptional conditions can the meniscus be accurately read. The practice of adding one-third of the per cent of the meniscus to the reading when made to the bottom of the meniscus, has its serious faults, especially in the hands of the average cream tester. It was shown in Bulletin 145 that the per cent of meniscus varied from 0.50 to 1.56 per cent and this in the hands of men of experience and training.

In a very recent article published by Doan and coworkers (Dairy Science, Vol. VI, No. 5), on cream testing where some data are given. These authors in tests of 10 samples of cream

[1] A mineral oil corresponding to the liquid petrolatum U. S. P., is very satisfactory and is to be recommended.

show that readings to the bottom of the meniscus varied from −0.26 to+1.22 per cent as compared with the Roese-Gottlieb method and in three of the samples the error exceeded the limit of error allowed for the Babcock test bottles. These three read-

TABLE 3

Showing the comparison of glymol reading when made under routine creamery testing

SAMPLE NUMBERS	GLYMOL READING	ROESE-GOTTLIEB METHOD	DIFFERENCE	SAMPLE NUMBERS	GLYMOL READING	ROESE-GOTTLIEB METHOD	DIFFERENCE
1	28.5	28.53	−0.03	13	32.0	32.17	−0.17
	28.5				32.0		
2	24.0	23.92	+0.08	14	30.5	30.42	+0.17
	24.0				30.0		
3	23.5	23.19	+0.31	15	30.5	30.53	−0.03
	23.5				30.5		
4	22.5	22.16	+0.09	16	36.0	35.67	+0.33
	22.0				36.0		
5	53.5	53.69	+0.06	17	31.5	31.90	−0.15
	54.0				32.0		
6	43.0	42.65	+0.35	18	27.5	27.49	+0.01
	43.0				27.5		
7	47.0	46.94	−0.19	19	26.5	26.21	+0.04
	46.5				26.0		
8	47.0	46.99	+0.01	20	36.0	35.95	+0.05
	47.0				36.0		
9	40.5	40.87	−0.12	21	36.0	36.10	+0.15
	41.0				36.5		
10	42.0	42.32	−0.32	22	29.0	29.43	−0.43
	42.0				29.0		
11	38.0	37.92	−0.17	23	27.5	27.19	+0.31
	37.5				27.5		
12	38.0	38.09	−0.09	24	25.0	24.87	+0.13
	38.0				25.0		
Averages					33.969	33.967	+0.002

The differences represent the difference of the average of the glymol reading.

ings being 0.59, 0.60 and 1.22 per cent higher than the gravimetric determinations. Doan and coworkers also make the following statement concerning the use of glymol (p. 407, l.c.) "Gregory and Hammond in the recent Purdue Circular No. 78 Revised, use Hunziker's method of including one-third the top meniscus or

flattening the meniscus with glymol." This method of including one-third the upper meniscus was not recommended to equal the accuracy of the use of glymol in Bulletin 145. In the conclusion reached and expressed in this Bulletin, Summary 17, the following statement was made: *"For uniform and accurate reading of the test, the meniscus must be eliminated. This can be done by the use of glymol."*

The subject of cream testing was exhaustively studied and findings presented in Purdue Bulletin 145, 1910. These results were accepted by the dairy industry as a decided advance in overcoming the difficulties in cream testing. The presentation of the data made under normal conditions and care, are the deciding factors regarding the value of any analytical method. Tables 2 and 3 both contain data obtained by the glymol method. By comparing these results it is evident that the glymol method has withstood the lapse of time and adverse criticisms as the new data confirm the old.

FIRST AMERICAN WORLD'S DAIRY CONGRESS A SUCCESS

J. H. FRANDSEN

The World's Dairy Congress which was held in Washington October 2 and 3, Philadelphia October 4, and Syracuse October 5 to 10, 1923, was attended by 231 delegates from 43 foreign countries, together with 1590 registered American delegates from 47 states and the District of Columbia, only one state not being represented; a total of 1821 registered delegates. Doubtless there were individuals who attended one or more of the 27 section meetings without registering.

Canada led with 100 delegates, England 22, Switzerland 12, Scotland 10, while the remaining 39 countries had from 1 to 9 each. Japan, Argentina, South Africa, and Russia are suggestive of the distant countries represented.

Of the United States delegation, New York State led with 313, Pennsylvania followed with 175, Illinois 133, District of Columbia 106, and in decreasing numbers down through the entire list of states.

The program listed 256 papers to be delivered at the 27 section meetings. Of these, 240 papers, including every phase of dairy science, practice and utilization were presented, 115 of these papers were contributed by foreign authors and were, with few exceptions, delivered in person by the author. Indications are that the printed proceedings of the Congress will consist of two volumes of approximately 900 pages. The editorial work is practically completed. The volumes will be published by the United States Department of Agriculture, and persons not registered as delegates or members of the Congress will doubtless be able to secure the proceedings in the same manner as other government publications, to the extent that they are available. Requests should be addressed to the

Superintendent of Documents, Government Printing Office, Washington, D. C.

The Congress was made possible by the contribution of from a few dollars to as much, in some cases, as one thousand dollars, by 402 organizations and individuals interested in the scientific and educational work of the dairy industry.

Some of the noteworthy comments on the results of the Congress may be summarized as follows:

So many men from so many countries can not come together and make acquaintanceships without being a real contribution to a better international understanding.

Many of our own people did not realize the high character of research work in progress in America until these reports and papers were heard at the same program with those from European scientists whose names have long been familiar to this country.

Foreign comment emphasizes the leadership of America in the sanitary supervision of its milk supply for large cities; its efficient pasteurization and wide distribution; the development of our ice cream trade.

One foreign paper, referring to our milk distributing and ice cream plants, says: "These are on a huge scale, almost quite unknown in these countries. So far, at any rate, as the American cities and large towns are concerned, distribution of milk in open vessels does not now exist." . . . . "It was not possible for any delegate to take in all that occurred at this Congress, but we saw sufficient to show us that the importance of dairying is receiving a large share of recognition from the governments and people of that country." . . . . "It would be impossible for us to say too much of the cordial manner in which we were welcomed everywhere we went and of the desire of all whom we met to impart such information as we desired."

Another foreign delegate, after returning home, states through the press: "The dairy industry in the United States is far more advanced than that of this country. They employ machines on a large scale, spend tremendous amounts of money in advertising, and have founded many colleges where every phase of dairy produce is dealt with. The

average American drinks twice as much milk as a Britisher; in fact, Americans are doing their best to produce an A-1 nation."

One delegate, commenting, says that where America is ahead of his country is in the successful way in which "the trade combines with educational and other authorities in propaganda to educate the children and the public as to the value and use of milk in the national diet.

One of the gratifying results was the recognition given the Congress by the President of the United States, the cabinet officers and the American metropolitan press. This is a real contribution to industry consciousness, a stimulus to closer understanding of the immense number of individuals engaged in a varied industry of science, education, business, production, manufacture, distribution and use.

Mention of the World's Dairy Congress would not be complete without a word of tribute to the two men who more than any one else made this undertaking the splendid success that it was. To President H. E. Van Norman and to Program Chairman L. A. Rogers the American Dairy Science Association owes a debt of gratitude. The first American Dairy Congress was a distinct success.

THE EFFECT OF STORAGE ON THE PEROXIDASE ACTIVITY OF WHOLE MILK POWDERS[1]

C. D. DAHLE AND L. S. PALMER

Divisions of Dairy Husbandry and Agricultural Biochemistry, University of Minnesota, St. Paul, Minnesota

Received for publication September 28, 1923

In a previous paper (1) the writers reported that certain milk powders exhibited greater peroxidase activity than others. This observation was made on fresh powders. The enzyme was inactive in case of drum-made powders dried under atmospheric pressure, but active when dried under reduced pressure or in a vacuum. Spray-made powders showed pronounced evidence of the presence of the enzyme. The difference in peroxidase activity in fresh powders is due largely to the degree of heat to which the liquid milk has been subjected in process of manufacture. It has also been observed by the writers that old powders in most instances showed but slight enzyme action; that the peroxidase activity decreased with the age of the powder.

In the present paper the investigation was carried on in connection with an experiment on the keeping quality of whole milk powders. The samples were stored under various conditions which made possible the studying of several factors influencing the peroxidase activity.

POWDERS STUDIED

The powders studied included Creamon, a certrifugal spray-made powder made by the Dick process; Klim, a pressure spray powder made by the Merrill-Soule Company; and Creamora A, an atmospheric drum-made powder made by the Dry Milk Company of New York.

[1] Published with approval of the Director as paper no. 411, Journal Series, Minn. Agric. Exp. Station.

TEST USED

The Storch test was used to denote the activity of the enzyme studied. It should be remembered that this test is not a quantitative test. A fresh supply of reagents was made up each time the samples were tested, as an interval of three months elapsed between each test. The powders were reconstituted with water to resemble normal milk in total solid content and the Storch test made on a 10 cc. sample.

FACTORS STUDIED

The factors studied which were under suspicion as influencing peroxidase activity included moisture and air, air, storage temperature, age of powder, and containers in which the powders were stored.

The effect of air and moisture

Before studying any factors a test was made of the fresh powders and it was found that the Creamora A powder showed no peroxidase activity, so it was not included in the present study.

Samples of Creamon and Klim were exposed for three hours at room temperature to an atmosphere partially saturated with moisture. The humidity of the atmosphere was 70 per cent. The moisture content of the powders was increased from 2.98 per cent to 4.31 per cent in case of the Creamon powder and from 2.57 per cent to 4.67 per cent in the case of the Klim powder. These samples gave positive Storch tests after the treatment, but the activity was slightly less than prior to this treatment. The powders were packed into two ounce screw top ointment jars (opaque glass) and placed in storage at 4°C., 20°C., and 37°C. and observed after three, six, nine, and twelve months (see tables).

The treatment received by the powders prior to storing was very detrimental to the peroxidase activity. After three months in storage there was not a trace of peroxidase. The same treatment was very conducive to tallowiness of the fat and insolubility of the powder. Powders stored at temperatures as high as 37°C. were highly discolored by the heat.

That air alone was a factor may be seen in the case of samples 1, 2, and 4 (tables). In number 1 the powders were milled to

TABLE 1

The peroxidase activity in a sample of Klim powder stored under various conditions

	STORAGE TEMPERATURE °C.	PEROXIDASE REACTION			
		After 3 months	After 6 months	After 9 months	After 12 months
(1)					
Powder milled in ball mill 1 hour and 25 minutes to break down air cell within the powder grains	20	+	+	±*	−
Packed in 2 ounce screw top ointment jars (opaque glass)	37	−	−	−	−
(2)					
Powder untreated and packed in 2 ounce screw top ointment jars (opaque glass)	20	+	±	−	−
	37	−	−	−	−
(3)					
Powder exposed 3 hours to partly saturated atmosphere, packed in 2 ounce ointment jars (opaque glass)	4	−	−	−	−
	20	−	−	−	−
	37	−	−	−	−
(4)					
Powder untreated, packed in 2 ounce ointment jars, without covers. Placed in dessicator and 29 inch vacuum drawn	20	+	+	+	±
(5)					
Powder untreated, packed in (Sealright) paper container	4	+	−	−	−
	20	+	±	−	−
(6)					
Powder untreated, placed in (Doubletite) containers	20	+	+	±	±
	4	+	+	±	±
	37	+	−	−	−

* ± Indicate that the activity was faintly noticeable.

expel the air within the particles. The milling destroyed the air cell. Number 2 was packed and stored without treatment, while a vacuum of 29 inches was drawn on powder in number 4. It

TABLE 2

The Peroxidase activity of a sample of Creamon powder stored under various conditions

	STORAGE TEMPERATURE °C.	PEROXIDASE REACTION			
		After 3 months	After 6 months	After 9 months	After 12 months
(1)					
Powder ground in ball mill 1 hour 20 minutes to break down air cell within the grains	20	+	+	±	−
Packed in 2 ounce screw top ointment jars (opaque glass)	37	−	−	−	−
(2)					
Powder untreated and packed in 2 ounce screw top ointment jars (opaque glass)	20	+	+	−	−
	37	−	−	−	−
(3)					
Powder exposed 3 hours to partly saturated atmosphere. Packed in 2 ounce screw top ointment jars (opaque glass)	20	−	−	−	−
	4	−	−	−	−
	37	−	−	−	−
(4)					
Powder untreated, packed in ointment jars without covers. Placed in dessicator and 29 inch vacuum drawn	20	+	+	+	±
(5)					
Powder untreated. Packed in (Sealright) paper containers	4	+	−	−	−
	20	+	±	−	−
(6)					
Powder untreated. Placed in tin (Doubletite) containers	20	+	+	±	±
	4	+	+	+	+
	37	−	−	−	−

will be observed that the peroxidase was much more active in sample 4 than in 2. The peroxidase of sample 1 was slightly more active than that of sample 2.

The influence of temperature

The temperatures at which the powders were stored was an important factor influencing the activity of peroxidase.

All samples except one stored at 37°C. gave a negative Storch test when examined after three months. Those stored at 4°C. and 20°C. were active after three months except the powders exposed to moist air before placing in storage. The heat at 37°C. greatly accelerated oxidation when air was present and caused an earlier destruction of the peroxidase. The Klim sample which was stored in the "Doubletite" tin container showed positive peroxidase after being stored for three months at 37°C. The reason for the activity of the enzyme in the Klim sample in this container was undoubtedly due to the small amount of air contained within the package. Creamon contains more air in a given package because of the large air cell within each individual grain, and the inability of the powder to pack closely because of the relatively large size of the grains.

Influence of time or age of powders

That time was a factor in the activity of peroxidase enzyme was clearly shown. There was a gradual decrease in the activity as the time advanced. This change was influenced by such factors as air, moisture, and temperature. When the powders were stored under vacuum there was still activity after one year. This was slight, however. Peroxidase activity was very slight after six months in storage under the best conditions.

The influence of containers

The containers in which the powders were stored played an important rôle. It was found that the containers which prevented the entrance of air and moisture gave the best results. A particular tin container known as "Doubletite" gave the best results. The activity of the enzyme studied was in evidence, though slightly, after one year in storage at 4°C. and 20°C.

Paper containers were not efficient, neither were the screw top ointment jars. It was impossible to prevent the entrance of air and even moisture when these containers were used.

SUMMARY

Factors known to favor oxidation, such as air, heat, and moisture, proved detrimental to peroxidase activity in the powders studied.

Powders stored under vacuum, and powders stored in containers which prevented the entrance of air and moisture, showed greater peroxidase activity than samples of the same powders stored in containers which permitted the entrance of air and moisture.

Increasing the moisture content of the powders by exposing them to atmosphere nearly saturated with moisture was very detrimental to peroxidase activity. No activity could be detected after three months in storage at 4°C., 20°C., and 37°C.

High storage temperature and high moisture content greatly accelerated the rate of destruction of the enzyme studied.

ACKNOWLEDGMENT

The writers wish to thank the International Dry Milk Company, Minneapolis, Minnesota, the Dry Milk Company of New York, and Merrell-Soule Company of Syracuse, New York, for supplying the milk powders used in this study.

REFERENCE

(1) PALMER, L. S., AND DAHLE, C. D.: Jour. Dairy Science, v, 1922.

THE COLOR OF COW'S MILK AND ITS VALUE

F. J. DOAN

Dairy Husbandry Department, Maryland Agricultural Experiment Station, College Park, Maryland

Received for publication December 20, 1923

Milk is an almost opaque fluid, made up of fat globules in temporary emulsion, colloidal casein and albumin, and various salts, sugar and albumin in solution. It varies in color, due to various reasons, from a yellowish white to nearly white or even to a bluish tinted white.

The observed color is a composite of many contributing factors. The chief of these is the yellow fat globules which are responsible primarily for the yellowish tints. When fat rises as cream most of the yellow color shows above the cream line. The size of these fat globules in the milk influences the composite color as well as does the color of the globules themselves (1), for the surface of small globules is greater in proportion to their size than the surface of the larger ones. Since light is reflected in all directions by these surfaces, milk with smaller fat globules would have a greater reflection and a greater dispersion of reflection, causing a whiter milk, even though the total amount and color of the fat and all other conditions were equal.

The colloidal ingredients also influence the opacity and whiteness of milk depending on the size of particles and the amount of these ingredients present.

As has been stated the greatest influence on color is produced by the fat. Where the fat of different milks is the same color, the yellowishness of the milk will roughly run in proportion to the amount of fat present. But the yellowness of milk fat itself is very different as between different milks so that in comparatively few cases should the above proportion be true.

Palmer and Eckles (2) have shown that the pigment in milk fat is carotin associated with a small amount of xanthophylls and that these pigments are the same as those found in green and yellow vegetation. Furthermore that the pigments are ingested with the food and secreted apparently unchanged in the milk fat. They were able to increase or decrease the color of the fat, at will, by changing the amount of pigmented food in the ration. This readily explains why summer milk fat is high in color and winter milk fat low in color. In the spring and early summer the cows usually have access to pasture or are fed considerable quantities of green feeds which contain comparatively large amounts of carotin; while in the fall and winter the cows are usually stall fed on hay, silage and grain containing comparatively small amounts of the pigment, depending to some extent on how bleached the hay is.

Two cows fed at the Maryland Station gave fat with 5 units of color on a ration of silage, beet pulp, and grain. When 20 pounds of green rye were added to the ration the color of the fat increased to 30 units, or approximately 6 times the depth of color, in the course of two weeks. This necessarily had a very pronounced effect on the color of the milk notwithstanding the fact that, the percentage of fat was greater at 5 units than at 30 units.

It is a well known fact that colostrum is exceedingly high colored. This is principally due to the intense color of the fat at this time. While colostrum is little different in fat content from normal milk, the greater amount of lipochrome in the fat has the power of deepening the color. In the cows noted previously, the color of colostrum fat was equivalent to 43 units on the day following parturition while six days later the color of the fat had fallen to 5 units in the case of one cow and to 5 units after sixteen days in the case of the other. This high color is not entirely dependent on feed, for in this case the feed had been rather constant over quite a period, consisting of timothy hay, corn silage, beet pulp and grain (a low pigmented ration) for sixty-five and forty-nine days, respectively. It is not definitely known why the colostrum fat is so highly colored, but it is probably due to a storing of the pigment in body fat laid on during the period

of non-milking; with a subsequent katabolism of these fats and their secretion in the first milk after calving. It may also be partially due to the absorption of the corpus luteum (yellow body), the pigment of which Palmer and Eckles (2) have shown to be largely carotin.

From these observations we can say that primarily the yellowishness of milk depends on: first, the color of the fat, or the amount of so called lipochrome present in the fat; and, second, the percentage of fat present, recognizing of course that other factors do influence the observed color to a minor degree. A factor of minor importance which has not been mentioned is the color of the milk serum or whey. It is an observable fact that milk coagulated for cheese making leaves a greenish-yellow whey. This color is due to a pigment known as lactochrome which Palmer and Eckles (2) found to be identical with the normal urine pigment, urochrome. It is not known what produces the variations observed in the color of the serum but variations which influnece slightly the color of the milk do occur.

Color in milk is a point of some commercial value, the average consumer preferring a yellowish milk, thinking it to be richer in cream (butter fat) than whiter milks. While this is true in general of milks where the pigmentation of the fat is approximately equal, it does not hold in the majority of cases. The demand for yellowish milks should however be encouraged for quite another reason.

It was at one time suggested that carotin and fat-soluble—A vitamin were identical or at least always found associated. While this theory has been disproved by Palmer and Kennedy (3), it is still a fact that milk from cows fed on ample quantities of green vegetation is higher in vitamin content than milk from cows fed on bleached hays, silage, most roots and grains (4). Thus it follows that summer milk is richer in vitamins than winter milk under prevailing conditions of production. Furthermore a highly pigmented milk fat indicates quite accurately the feeding of materials ordinarily considered rich in vitamins. From these facts it would seem that milk containing a high colored fat would

carry a comparatively large amount of vitamins. But on the other hand, in consideration of Palmer and Kennedy's (3) results, a low colored fat would not necessarily indicate that such a milk was low in vitamin content, although in a large majority of cases such would undoubtedly be true under commercial conditions. In this discussion the references to vitamins apply more particularly to vitamin A, although it is believed that the statements would still hold true for vitamins B and C as well.

COLOR INSTRUMENTS

An instrument has been devised by Prof. R. W. Wood of the Johns Hopkins University, for measuring the color of milk. This instrument compares the color of light transmitted through a layer of milk 1 cm. in thickness with the color of the same light passing through a wedge of yellow glass and falling on a white surface. A match is secured by changing the position of the yellow wedge, the thick end of the wedge giving a more yellow color on the white surface than the thin end. The instrument is arranged so that not only the depth of color of the light falling on the white surface may be altered, but also the amount of light allowed to fall on this surface. The latter is regulated by adjusting the slit, through which the light passes, by means of a thumb screw. The readings are made by noting at what point on the wedge a color match is secured, the wedge carrying a scale graduated from 0 to 15 in centimeters, being subdivided into millimeters.

This method of measuring color seems not to be entirely accurate since it has been noted, in some cases, that whole milk, and the skim milk from this whole milk, give the same reading; while comparison in test tubes show the whole milk considerably more yellow than the skim milk.

An instrument for measuring the color of milk fat and of milk serum is the Lovibond tintometer which was used by Palmer and Eckels (2) in their work. This instrument is a colorimeter making use of colored glasses as the standard. The glasses are furnished in graduated units of three colors—red, yellow and blue. Various combinations of these three primary colors will produce

almost any tint of any color. Since in milk fat the ratio between yellowish tints and reddish tints is not constant it is difficult to find a solution which can easily be used as a standard. Potassium dichromate can perhaps best be used, but the use of standard glasses is much simpler and far easier to manipulate.

In preparing the fat for a color reading, at least one quart of milk is churned in a small glass churn, the resulting butter rendered at 60°C. to 70°C. and the curd removed as completely as possible by centrifugation in a separatory funnel, washing with hot water. The fat is then filtered, while hot, through paper on a warm water funnel, or in an oven at 60°C. to 70°C. and the filtrate put into a cell ½ inch deep. This one-half inch of fat is then matched in the tintometer with the standard glasses which are numerically graduated according to depth of coloring, usually about 1 unit of red being required to 10 or 15 units of yellow for a perfect match. The number of units of both yellow and red used is the color reading of the sample. For instance: yellow, 25 units; red, 2.1 units. This method of ascertaining the color of the milk fat and indirectly the nature of the ration being fed the cow, is superior to the direct readings on the milk because it does away with other factors not directly concerned. Either method is an arbitrary one but the readings on the milk itself are rendered higher or lower, due to the amount of fat present, while those on the fat proper are not in error in this regard. To show the changes in fat pigmentation due to alteration of rations, two cows (previously mentioned) were fed the same rations, and color readings made on their milk fat over a period of several months with results shown in the table. The rations consisted of concentrates, and beet pulp, which were practically constant during the entire period. Hays, corn silage, soilage crops and green corn were added or removed from time to time as noted opposite the date.

Readings on two cows fed the same ration

cow 324			DATE	CHANGES IN FEED	cow 287		
Test	Fat color				Fat color		Test
	yellow	red			yellow	red	
4.50	4.5	0.5	April 16		5.0	0.8	5.40
4.40	10.0	1.0	April 23	Green rye	7.3	0.8	5.45
4.50	17.2	1.1	April 30		10.0	1.0	4.35
4.50	29.0	1.0	May 7		10.0	1.0	3.80
4.50	24.0	1.1	May 14		11.4	1.1	3.75
4.45	16.0	1.3	May 21		15.0	1.2	3.80
4.40	20.0	1.5	May 28	Green veitch	30.0	1.5	3.65
4.50	Lost		June 4		Lost		3.60
4.65	30.0	1.3	June 13		20.0	1.2	3.80
4.55	23.0	1.0	June 18		25.0	1.0	3.65
4.40	32.0	1.0	June 25		30.0	1.0	4.00
4.30	31.2	0.7	July 2	Green hay	22.2	1.1	3.55
4.65	19.9	0.9	July 9		25.0	1.0	3.65
4.60	29.0	1.2	July 16		25.0	1.2	3.60
4.50	31.5	1.0	July 23	Green corn	30.0	1.1	3.95
4.60	29.0	1.1	July 30		24.0	1.3	3.85
4.40	26.0	1.3	August 6		15.0	1.2	3.60
4.60	25.0	1.5	August 13	Green alfalfa	20.0	1.4	3.90
4.35	26.8	1.5	August 20		20.5	1.5	3.70
4.30	28.5	1.7	August 27	Yellowing hay	18.1	2.0	3.60
4.40	21.1	1.6	September 3		17.2	1.5	3.60
4.40	17.7	1.7	September 10		16.2	1.4	3.90
4.35	29.0	1.5	September 17	Sorghum corn	22.2	1.2	3.65
4.80	29.0	1.3	September 24	Green soy beans	19.0	1.4	4.30
4.25	20.0	1.5	October 1		23.0	1.2	4.00
4.90	30.0	1.5	October 8	Cured timothy	21.0	1.1	4.20
4.80	17.2	1.3	October 15	Silage	11.0	1.0	4.20
5.30	11.0	1.3	October 22		6.0	1.0	4.60
5.50	11.0	1.1	October 29		5.0	0.9	4.40
5.60	6.5	0.7	November 5		4.7	0.8	4.60
5.75	4.1	1.0	November 12		5.0	0.8	4.60

In a study of this table two things stand out, namely, that all the green roughages produced milk fat with a comparatively large amount of pigment and the lack of green roughages gave rise to milk fat which was comparatively low in pigment. In several cases the change from one green roughage to another seemed to lessen the color of the milk fat temporarily. The decline in color after October 8 is striking, when cured timothy

and silage were substituted for green soy beans; as is also, the rise in color when green rye was substituted for silage just previous to April 30. Throughout the period, cow 267 gave almost twice the amount of milk given by cow 324. This explains the lower color readings on her milk fat. The discrepancy in color of milk fat for cow 324 May 21 and May 28 can be partially laid to the fact that she was "off feed" during some of this time.

While this work is largely a preliminary observation, the results do show that the pigmentation of the fat, roughly runs parallel to the amount of green feeds assimilated.

In a final analysis it may be found that the color of cows milk or the color of milk fat is of no great importance, but from our present knowledge color does seem to be an indication of the vitamin A value of milk used for a food and possibly an indication of the presence or absence of other vitamins as well. This statement, applies only to milk produced under present commercial conditions.

REFERENCES

(1) HEINEMAN: Milk.

(2) PALMER AND ECKLES: Carotin—The principal natural yellow pigment of milk fat. Missouri Research Bulletin Nos. 9, 10, 11, 12 and 13.

(3) PALMER AND KENNEDY: The relation of plant carotinoids to growth and reproduction of albino rats. Jour. Biol. Chem., May, 1921.

(4) GOLDING, JOHN: Variation of the vitamin A content of cow's milk under different conditions of feeding. Paper W.D.C., 1923.

DUTCHER: Factors influencing the vitamin content of cow's milk. Paper W.D.C., 1923.

TRUE PROTEIN VERSUS CRUDE PROTEIN AS A BASIS FOR COMPUTATION OF FEEDING STANDARDS

E. B. FORBES

Pennsylvania Institute of Animal Nutrition, State College, Pennsylvania

Received for publication December 17, 1923

First let us understand that a feeding standard is not a statement of absolute scientific fact, but a device of convenience, based upon rather generalized scientific truths, and intended as a guide in practical animal feeding.

Feeding standards, of course, may set forth nutritive requirements of any kind whatsoever, but as acutally used they all represent, in terms of some sort, the two factors of nitrogenous and non-nitrogenous organic nutriment.

The method of statement of the first-mentioned factor, of nitrogenous nutriment, is the subject of this consideration.

As we conceive this problem it is, in reality, not one of evidence for the establishment of scientific truth, but rather one of analysis of a situation depending upon recognized facts, for the determination of the most useful of two conventional procedures.

The justification for this discussion lies in the fact that within comparatively recent years our understanding of the whole subject of protein metabolism has undergone revolutionary change, and this subsequent to the establishment of the current usage of the two methods of expression of the protein component of rations.

This subject was discussed by Armsby as late as 1917,[1] and from his presentation we quote the following:

> For the present the only available measure of the protein values of feeding stuffs is the total amount of digestible protein which they contain. In the application of this method it becomes necessary to decide

[1] Armsby: The Nutrition of Farm Animals, 1917, pp. 684–688.

whether the basis of comparison shall be the "crude" protein or the "true" protein as determined by existing conventional methods; in other words, to decide what value, if any, shall be assigned to the non-protein.

It would appear that the value of the non-protein of a feeding stuff as a source of body protein must be determined by precisely the same thing which is believed to measure the value of an individual protein or of the mixed proteins of feeding stuffs, viz., the kinds and proportions of amino acids which it can yield, since there is no evident reason why an amino acid existing already formed in a feeding stuff should differ in value from the same substance split off from protein in the process of digestion. If this be admitted, however, the distinction made in recent years between protein and non-protein in feeding stuffs becomes rather meaningless. If the value of each is measured by its amino acid content, then what is needed to fix the production values of feeding stuffs as regards protein is a knowledge of the kinds and amounts of these compounds which the feeding stuff as a whole (i.e., its crude protein) can furnish, irrespective of whether they exist in a soluble, as it were predigested, form or are first produced in the digestive tract of the animal.

The conclusions of Armsby, in full,[2] are as follows:

"It seems clear that the evidence is insufficient to warrant any general conclusions regarding the nutritive value of non-protein, if indeed any general statement regarding such a heterogeneous group is possible. Ultimately, it may be that studies of the amino acid yields of the total nitrogenous matter (crude protein) of feeding stuffs, or comparisons of its relative efficiency in supporting maintenance or growth, will lead to the formulation of production values for the crude proteins of different materials, but for the present the writer feels that the safer course is to make the digestible "true" protein, so-called, the basis of comparison.

"While some experiments, notably the Copenhagen experiments on dairy cows, seem to indicate a relatively high value for the non-protein of roots especially, most investigators, particularly Morgen and his associates, have, as already noted, found them decidedly inferior to protein. It is true that the non-protein contains amino acids which may at times be utilized indirectly by herbivora through the agency of

[2] Loc. cit., p. 687.

the microörganisms of the digestive tract, but even this indirect utilization seems to be rather limited in extent in most instances. The conventional "true" protein, on the other hand, may be regarded as representing approximately the real proteins of a feeding stuff and it would seem that these mixed proteins are likly to supply more nearly a balanced amino acid mixture in digestion than would result from the inclusion of the non-protein. Investigations of the protein values of feeding stuffs should doubtless take account of whatever amino acids the non-protein supplies, i.e., they should relate to the crude protein. With continued study of these relations, it may be hoped that greater clarity may be attained, but until that end is reached, the digestible "true" protein seems the safer basis for the formulation of tables of the production values of feeding stuffs and for the computation of rations.

Whatever error is thus involved tends to make the protein content of the rations somewhat higher than if the crude protein were made the basis of the computation. It is, therefore, an error on the safe side, since a deficiency of protein may limit production while a surplus at worst simply tends to increase the cost of the ration, and the difference in the latter respect is seldom considerable.

In discussing the same matter Henry and Morrison[3] say, in part:

Whether these amids can be used for the same purposes in the body as are the proteins of the food, has long been a disputed question. If the mixture of amids in a feeding stuff contains the proper proportion of the various amino acids (the protein building stones), it now seems certain that these amids can be used the same as the true proteins.

For example, about one-third of the crude protein in legume hays usually consists of amids. Nevertheless, the crude protein in these feeds is much more efficient for maintenance, growth, or milk production than the crude protein of the cereal grains, which contains but a very small proportion of amids. Similarly, about half the crude protein in corn silage consists of amids, largely formed by the breaking down of proteins in the ensiling processes, for amids form only about 15 per cent of the crude protein in dried corn fodder. Yet on the dry basis, corn silage is more valuable than corn fodder for stock feeding.

From these facts it appears logical in making up balanced rations for stock, to base the computations on the total amount of digestible

[3] Feeds and Feeding: Henry and Morrison, 1923, p. 64.

crude protein, as is advocated in the Morrison feeding standards. In view of our present knowledge it seems unwise to ignore entirely the value of the amids as sources of nitrogen for body uses, as is done in the Armsby and Kellner feeding standards.

A careful examination of this whole question reveals within it boundless possibilities for inconclusive discussion, for the reason that it is essentially like an incomplete mathematical problem, being unsolvable on a scientific basis.

The salient points in this situation are the following:

The distinction between protein and non-protein nitrogen has largely lost its significance, in the light of the newer knowledge of protein metabolism. In different feeds there is no uniform relation between non-protein and true protein nitrogen, either as to kind or as to quantity. Non-protein nitrogen is so heterogeneous in its nature—so lacking in uniformity of composition and nutritional value, that it is impossible to speak of non-protein, or to compare true protein and non-protein, in general terms, with accuracy or satisfaction. Some true proteins, because of a lack of essential amino acids, may be of limited value as protein; non-protein may be composed of varying combinations of useful and useless amino acids and amids, as well as a diversity of other nitrogen compounds—nitrogenous extractives, nitrogenous lipoids, nitrogenous glucosids, alkaloids and organic bases, as well as nitrates and ammonium salts. The nutritive value of non-protein nitrogen to contribute to the protein requirement is determined, then, just as is that of protein, by its individually characteristic amino acid composition, and by the demand for the several amino acids, as varying with and depending upon the feed combination in which it is used, and the particular nutritive requirements of the animal involved.

It should be noted that Armsby did not deny the nutritive value of non-protein nitrogen, in fact he definitely advocated[4] the consideration of the amino acid content of the non-protein in studies on the protein values of feeding stuffs; but at the same time he expressed the belief that until greater clarity is reached,

[4] Loc. cit., 687, lines 33 to 40.

as to the value of non-protein nitrogen "the digestible 'true' protein seems the safer basis for the formulation of tables of the productive values of feed stuffs and for the computation of rations."

Further, he made his position regarding this matter still more clear[5] by explaining that so long as the protein requirements of animals and the protein contents of feeds are both stated in the same terms, it will commonly make no significant difference whether this be on the relatively low level of true protein or on the higher level of crude protein figures.

It seems to me impossible to take serious exception to this point of view, and I believe that the underlying facts are understood alike, all the way around.

It is my belief, therefore, that there is in this problem no ground for important scientific difference, but merely slight dissimilarities of feeling as to evidence which is understood in practically the same way by every one.

But there remains the difference in usage—which, from a practical point of view is important, since results of experiments can be compared only if stated in the same terms, and since there is no convenient and accurate way of computing from one of these standards to the other.

The matter under discussion has to do especially with animal feeding. Protein figures in the literature of animal feeding are predominantly on the "crude" basis. Is there practical advantage, therefore, in changing to the "pure" protein basis; and is there warrant for a dual form of statement?

The element of conventionalism is so prominent in both the true protein and the crude protein conceptions that a choice between them seems essentially unimportant—but there remains the practical consideration of the use of the literature.

To the man who is inclined to look deeply into the subject the "true" protein conception must seem less conventional, more scientific, and more satisfactory than the idea of "crude" protein, for the reasons that "true" protein is essentially more of one sort,

[5] Loc. cit., 325.

with a more definite and a more uniform nutritive value, than is "crude" protein. In my opinion, however, the difference is not one of importance in connection with the usefulness of data stated in these terms.

The scientific student, in the field of protein metabolism, will think in terms of amino acids. The true protein of a feed does not contain all of its amino acid fraction, while the crude protein contains all—and much else—some of related character—some not related.

All things considered, the writer favors the continuance of the use of the crude protein standard in the literature of animal production, and a separate statement of the true protein wherever it will be effective as a step toward recognition of the one fact of outstanding significance in this relation—that the nutritive value of protein, as protein, depends essentially upon the amino acids which it contains.

In the more critical sense the proteins of feeds can be compared only in terms of the amino acid balance of the rations in which they are used. This attitude being impracticable, for the present, at least, especially in connection with feeding standards, we have no recourse other than to make use of the highly conventional standards which we have discussed. In this connection, however, a very great improvement in the significance of protein values seems quite possibly attainable through our learning to determine the true digestibility of protein; when, indeed, we shall have done so. The writer believes that this is a promising subject for research, and that it should be vigorously prosecuted.

STUDIES IN THE GROWTH AND NUTRITION OF DAIRY CALVES

X. SELF-FEEDING A GRAIN MIXTURE TO YOUNG CALVES

ANDREW C. McCANDLISH

Dairy Husbandry Section, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa

Received for publication April, 1922

The use of the self-feeder in the raising of dairy calves has already been discussed in papers VII and VIII of this series, so it will not be necessary to go into the history of the work here. In the two previous papers a trial of sixty days' duration with young calves was reported and also an attempt to raise heifers to producing age with the aid of the self-feeder. In each case the animals were given a choice of grains and were allowed alfalfa hay at free will while milk was hand fed.

EXPERIMENTAL WORK

In the trial reported here 4 young calves, averaging sixteen days in age, were used. Information concerning them is given in table 71 and where necessary it is calculated to the day on which the trial started, namely, October 6, 1921.

The trial lasted for six periods of thirty days each. The calves were started on whole milk, hand fed, according to their apparent needs, and in the third period the substitution of skim milk started, though it was not absolutely completed until the last period.

Good alfalfa hay was kept before the calves at all times and they were provided with a mixture of 5 parts cracked corn, 2 parts ground oats, 2 parts wheat bran and 1 part old process linseed oil meal, by weight, in a self-feeder. Salt was provided at free will and the animals were watered twice daily.

TABLE 71

Animals used

NO.	CALF 565	CALF 570	CALF 572	CALF 573
Breed	Jersey	Ayrshire	Jersey	Ayrshire
Birth weight, pounds	51	55	41	58
Age, days	32	18	8	8

TABLE 72

Total feed consumption for the group

PERIOD	WHOLE MILK	SKIM MILK	ALFALFA HAY	GRAIN MIXTURE
	pounds	*pounds*	*pounds*	*pounds*
I	1056		27	39
II	1210		107	147
III	1206	140	160	319
IV	728	820	221	483
V	48	1770	162	623
VI		1880	180	806
Total	4248	4610	857	2417
Average per calf	1062	1153	214	604
Daily average per calf	5.9	6.4	1.2	3.4

TABLE 73

Average live weights and body measurements

TIME	LIVE WEIGHT	HEIGHT	DEPTH	WIDTH
	pounds	*inches*	*inches*	*inches*
Start of Trial	59	25.6	10.9	6.0
End of period I	97	27.9	12.0	6.9
II	141	30.5	13.6	8.1
III	183	33.1	15.3	9.1
IV	239	34.6	16.9	10.0
V	297	36.2	17.7	11.0
VI	346	38.3	18.7	12.2

It will be noted that the grain consumption is heavy, being at all times greater than the hay consumption. On the average each calf consumed 3.4 pounds of grain daily and only 1.2 pounds of alfalfa hay.

The live weight of each animal was obtained at the end of each thirty-day period. The body measurements, height at withers, depth of chest and width at hooks were also determined. The animals showed excellent growth. This is more readily realized when the rates of gain are compared with those reported for normally fed heifers in paper III of this series. The normally fed heifers have an advantage in age of fourteen days in the comparison with the self-fed calves and yet at the end of the sixth thirty-day period, when the trial ended, the self-fed heifers showed increases of 491, 37, 56 and 77 per cent in live weight, height, depth and width, respectively. The corresponding increases or the heifers fed normally were 309, 34, 57, and 67 per cent.

The self-fed heifers showed good gains, but the cost of the gains is a very important factor. Using the same feed costs as were used in the other papers of this series it is found that the cost of feed for the normally fed heifers up to six months of age was $35.57, and for the self-fed heifers that had a choice of grains it was $35.81, while for the heifers in the work reported here, where a grain mixture was used the cost was $29.96 or a considerable reduction.

If the cost per pound of live weight gain be considered it is found that it amounts to 14.4 14.1 and 10.4 cents per pound for the various groups in the order mentioned above. This would indicate that calves can be raised economically when self-fed a mixture of grains. This is due largely to the fact that the amount of high priced feeds such as oil meal are limited and cheaper grains, such as oats, form a larger part of the ration.

SUMMARY

From the work reported here it would appear that dairy calves can be fed economically until six months of age with a self-fed mixture of cracked corn, ground oats, wheat bran and linseed oil meal. The proportions of the feeds in the mixture can be adapted to ruling prices. Alfalfa hay can be self-fed and the milk hand fed according to the requirements of the individual calves.

ASSOCIATIVE ACTION AS A CAUSE OF YELLOW COLOR IN YEAST COLONIES

B. W. HAMMER

Dairy Section, Iowa Agricultural Experiment Station, Ames, Iowa

Received for publication May 31, 1923

INTRODUCTION

During the past few years many samples of milk, cream and butter have been examined for the general types of yeasts contained by plating on whey agar, 1 cc. of a 1 per cent solution of tartaric acid being added to each plate at the time of pouring to restrain bacterial growth. While most of these samples came from the neighborhood of Ames, a considerable number were from other points in the state and some few from outside the state. Among the colonies observed the production of colors other than pink was extremely rare. The results herein reported deal with the presence of a yellow color, as a result of associative action, in colonies that were apparently yeasts but in which the effect of mold growth was evidently important.

EXPERIMENTAL

A canary yellow colony that was apparently a yeast was observed on a whey agar plate showing a growth of both yeasts and molds. Examination of the colony under the low power showed the structure to be that common to yeasts and a stained preparation revealed only budding cells so a tiny bit of the colony was shaken up in a water blank and whey agar plates poured for purification. After incubation at room temperature the plates showed numerous yeast and bacterial colonies but none of them were yellow and none became yellow even after prolonged holding.

At a later date a whey agar slope inoculated from a plate poured for a yeast and mold count on storage butter showed a bright yellow growth, and a microscopic examination of this proved the presence of both yeast and bacterial cells. The slope also showed a mold growth covering a good portion of the surface; the mold was probably carried over from the plate since this was heavily seeded and showed various types of yeast and mold colonies. A small amount of the yellow material from the slope was shaken up in a water blank and plated out and yeast and bacterial colonies quickly developed but all were white with no suggestion of a yellow color. Although the presence of bacteria in cultures of yeasts picked from plates is very common as a result of the bacterial cells being carried along by the yeast cells, it seemed advisable to make mixtures of the yeast and the bacterium with the idea that the color production might be the result of associate action between these two organisms. A considerable number of such mixtures were made on whey agar slopes but all of them failed to develop a yellow color.

Later observations of the plates from which the bacterial and yeast colonies had been picked showed the relationship necessary for the development of color. Two mold colonies that were probably carried over from the original slope had started to develop at some distance apart and where the molds had come in contact with or close to the yeast colonies, which by this time were up to several millimeters in diameter, the yeast colonies had assumed a bright yellow color. It was common to find only the part of a yeast colony toward the mold showing the yellow color, although eventually the entire colony became yellow. In some instances spore stalks later came out of the yeast colonies so it seems that the mold must have grown through them. A pure culture of the mold (mold 1) and a number of the yeast (yeast 1) were secured and used in various inoculation experiments.

By inoculating yeast 1 on a whey agar slope and, after a good growth had developed, inoculating mold 1 near it, a yellow color was regularly secured in the yeast growth when the mold had come near to or in contact with it. The continued development of the mold soon resulted in the yeast growth being entirely covered up so that the typical yellow color was no longer evident.

A yellow color in the yeast growth could be obtained by inoculating the yeast and mold at the same time or even by inoculating the mold first but when the yeast growth was heavy, as occurred when the yeast was inoculated first, the appearance was the most striking.

Although a yellow color was readily produced on whey agar slopes, plate cultures were more satisfactory as a means of showing the color production by the action of the two organisms. Plates showing a considerable number of colonies of yeast 1 were repeatedly inoculated at one or more points with mold 1 and the development of the yellow color followed. As the mold spread, a yellow color appeared in the nearby colonies—usually on the side toward the mold first—and then as the mold growth increased more distant colonies became yellow. A considerable number of colonies were cultured soon after they had become yellow by dipping a sterile needle into them and inoculating on whey agar slopes. In the inoculations molds and yeasts were both evident in most cases while in others only yeasts were found and these of course gave a white growth; from these results it seems that the mold growth in the yeast colonies does not necessarily need to be heavy for the yeast colonies to assume a yellow color.

As already suggested, the portion of the yeast colony toward the mold was most likely to show a yellow color first. In some instances the colonies were yellow mainly along a considerable portion of the edge so that the yellow area was shaped like a horse shoe.

An attempt was made to find out whether or not thermostable products of one of the organisms in the presence of the other organism could induce color production. Yeast cultures on whey agar slopes were destroyed by heat, usually 60° to 65°C. for forty-five minutes, and then the mold inoculated but in no instance was there a development of a yellow color. When mold cultures on whey agar slopes were heated and then the yeast inoculated the growth appeared white. Yeast colonies on whey agar plates were also destroyed by heat and molds inoculated but no yellow color developed.

The medium used apparently has considerable influence on the color production by the yeast and mold combination. In a small

number of trials a yellow color was not obtained on synthetic agar, beef extract agar or beef infusion agar while whey agar was repeatedly satisfactory. It is possible that the failure to secure color production with most of the media used was in part due to a poorer growth but it does not seem that this could be the only factor involved.

The mold that was found active in the production of the yellow color was studied with the idea of determining the species. The general characters suggested that it was to be classed as Aspergillus niger. A number of species of Aspergillus were then secured from two laboratories and these tried out for the production of a yellow color in combination with yeast 1. Among cultures of A. flavus, A. niger, and A. terreus from one laboratory and cultures of A. niger, and A. flavus from another, the two cultures of A. niger were the only ones that gave a yellow color in combination with the yeast. These results, which were repeatedly secured, strengthened the belief that the mold isolated was A. niger and showed that the production of the yellow color occurred with cultures of A. niger other than the one isolated but did not occur with certain species belonging to the same genus.

An attempt was made to determine whether or not the production of a yellow color was peculiar to yeast 1 when grown in combination with A. niger or whether it occurred with other yeasts. Color production in colonies on whey agar was observed with a considerable number of yeasts that were grown in combination with mold 1 or with A. niger from other laboratories. A series of cultures belonging to a group of yeasts that produce changes in milk only slowly, if at all, and with which the yeast originally found is to be classed, regularly gave a bright yellow color when grown with A. niger although all gave a white or dirty white growth when grown alone. The lactose fermenting yeasts, T. cremoris and T. sphaerica, also gave a yellow color when grown in combination with the mold. A yellow color was not secured with the yeasts having a pink appearance in pure culture or with certain other types that gave spreading colonies on whey agar. The results show that the production of a yellow color, although it does not occur with all species, is common among

yeasts when they are grown in combination with A. niger, and that accordingly this color production is not likely to be an aid in the classification of the yeasts common in dairy products.

The production of oxalic acid by strains of A. niger[1] and related organisms suggested an attempt to influence the color production of yeasts growing in pure culture by putting a small amount of sterile oxalic acid solution near the colonies. After the development of medium sized colonies on plates, a drop of the sterile acid solution was placed near a number of them and then observations frequently made. No yellow color was secured in any of a considerable number of trials. Attempts were also made using citric acid in place of the oxalic acid, but again only negative results were secured. It seems accordingly that some factor other than the production of oxalic or citric acid by the mold influences the yeast in such a way that it shows a yellow color in the colony. Negative results from the acids would be expected from the fact that when the yeast was grown near killed cultures of A. niger no yellow color developed.

Since the relationship between the molds and yeasts was recognized as a cause of the yellow color production, yellow colonies that were evidently yeasts have been noted on plates a number of times. An examination of such plates has invariably shown the presence of a mold quite like mold 1 and in no instance has a yeast that produces a typical yellow color alone been secured. Frequently the yellow color appeared definitely in a portion of the colony first and then later the colony showed the color throughout.

In one instance a yeast that produced a brownish color in pure culture was isolated. This organism persisted in its color production through a long series of transfers. The color however did not at all resemble the yellow color formed as a result of the combined action of a yeast and mold and there was more danger of its being erroneously classed as a pink than as a yellow.

Aspergillus niger does not seem to be common in dairy products and it may be that its presence in plates poured with these

[1] Aspergillus niger group. Charles Thom and James N. Currie, Jour. Agr. Res., vii, 1, October 2, 1916.

materials is due to air contamination; more than one colony of A. niger on a plate has only rarely been observed.

The development of a decided yellow color by the combined action of a yeast and mold may play a part in the development of a yellow color on certain dairy products such as cheeses, where the conditions for the growth of organisms are very favorable. It seems certain that on some of these materials colored growths occur which cannot be reproduced by a pure culture of any of the organisms present; the fact that associative action of a yeast and mold can yield a yellow color on an agar plate suggests that the same thing may occur where organisms are growing in masses on cheese or some other material.

SUMMARY

The data presented show that A. niger growing near to or in contact with certain yeast colonies on whey agar slopes or plates resulted in the yeast colonies showing an intense yellow instead of the usual white color. This condition occurred with a number of different yeasts common in dairy products, but not with all of those studied. The mechanism of this color production was not worked out, but it is probably rather complex since neither organism growing in contact with killed cultures of the other produced the yellow color.

The species of Aspergillus other than A. niger which were tried did not yield a yellow color when grown with yeasts that did give a yellow color with A. niger.

It seems that the associative action of yeasts and A. niger may be responsible for the yellow color occasionally observed with such products as cheese.

VARIATIONS IN AMOUNT OF MILK AND PERCENT OF FAT IN THE MILK FROM DIFFERENT QUARTERS OF THE COW'S UDDER

J. B. FITCH AND LYNN COPELAND

Department of Dairy Husbandry, Kansas State Agricultural College, Manhattan, Kansas

Received for publication December 15, 1923

Facts concerning the secretion of milk are becoming of more and more interest to the dairy cattle breeder. Variations in the percentage of fat in the milk are of especial importance. The object of this paper is to present a rather striking fact bearing on this subject, which may with further accumulation of data contribute to more knowledge regarding milk secretion. This data was obtained in connection with some experimental work being done at the Kansas Agricultural College regarding milk secretion.

Previous work in regard to the percentage of fat from the various quarters, was published by Beach in Storrs Report 1904, page 132. In this work only one milking was used and no attempt was made to determine the permanency of the variations. The results did show that when a large number of cows were considered, there was practically no difference in the percent of fat from the various quarters.

In obtaining this data three Jersey cows and two Holsteins were used. The first period lasted two days, or four milkings. Each quarter was milked in a separate pail, four small buckets being used. The milking was done as in common practice, no one quarter being milked dry before the others. The milk from each quarter was weighed, sampled, and tested separately. Two weeks later the exact experiment was duplicated to verify it and test the permanency of the variations.

TABLE 1

NUMBER OF COW	TRIAL	TIME OF MILKING	FRONT UDDER		REAR UDDER		PER CENT OF FAT IN MILK			
							Fore-udder		Rear-udder	
			Right	Left	Right	Left	Right	Left	Right	Left
			pounds	pounds	pounds	pounds	per cent	per cent	per cent	per cent
I	1	a.m.	1.9	1.0	3.4	3.1	3.7	3.8	4.55	4.2
		p.m.	2.3	1.3	3.7	2.8	3.85	5.1	4.5	4.0
		a.m.	2.4	1.1	4.0	2.4	4.1	4.4	5.05	4.3
		p.m.	2.1	0.9	3.2	2.1	4.9	4.3	5.2	4.7
	2	a.m.	2.4	1.0	3.5	2.2	4.7	5.4	5.1	4.8
		p.m.	2.4	1.1	3.3	2.3	4.3	4.5	4.8	4.4
		a.m.	2.3	1.1	3.2	2.1	3.8	4.5	4.8	4.3
		p.m.	2.3	1.2	3.3	2.3	4.8	4.8	4.9	4.4
II	1	a.m.	4.5	3.2	7.0	4.7	2.15	2.75	1.85	1.9
		p.m.	5.1	5.1	10.2	7.1	3.3	3.4	3.5	3.5
		a.m.	4.2	3.6	9.0	6.4	3.05	3.5	3.2	3.1
		p.m.	4.4	4.5	9.1	7.0	3.8	4.4	4.3	3.9
	2	a.m.	5.7	5.9	9.3	7.3	3.1	3.8	3.7	3.3
		p.m.	3.8	3.9	7.9	6.4	3.5	3.6	3.2	3.5
		a.m.	4.1	4.4	8.3	6.4	3.2	3.7	3.5	3.7
		p.m.	3.9	5.2	9.3	7.5	3.9	3.6	4.0	3.9
III	1	a.m.	0.9	1.5	1.4	1.4	5.3	5.7	4.2	4.3
		p.m.	0.8	1.5	1.7	1.5	5.25	6.15	6.35	5.9
		a.m.	0.7	1.6	1.5	1.3	5.1	5.75	5.4	5.2
		p.m.	0.7	1.3	1.5	1.4	4.8	5.5	5.7	5.6
	2	a.m.	0.7	1.7	1.8	1.6	5.3	5.8	5.8	5.3
		p.m.	0.7	1.7	1.4	1.3	5.0	5.6	5.5	5.3
		a.m.	0.6	1.4	1.4	1.3	5.7	5.5	7.4	5.4
		p.m.	0.7	1.6	1.6	1.6	5.4	5.8	5.7	5.8
IV	1	a.m.	2.1	2.1	1.2	1.6	6.0	6.1	4.15	4.2
		p.m.	1.8	1.9	1.3	1.9	6.1	6.5	6.8	7.0
		a.m.	1.2	2.0	1.3	1.9	6.0	6.2	5.65	5.7
		p.m.	1.5	1.7	1.0	1.6	5.9	6.0	6.1	6.0
	2	a.m.	2.1	2.0	1.3	2.0	6.2	6.2	5.8	5.9
		p.m.	0.9	1.6	1.2	1.7	6.2	6.3	6.4	6.0
		a.m.	1.5	1.5	1.0	1.5	6.1	6.4	7.0	6.4
		p.m.	1.9	1.8	1.3	1.7	6.2	6.2	6.6	6.0
V	1	a.m.	2.0	3.7	3.6	3.7	4.1	5.5	5.5	4.45
		p.m.	2.0	3.1	3.7	3.5	5.25	6.0	5.95	6.2
		a.m.	1.9	3.5	4.2	3.7	4.45	5.5	5.3	5.05
		p.m.	1.5	2.7	3.1	3.8	4.1	5.0	4.5	4.6
	2	a.m.	1.3	3.0	4.1	3.3	4.3	6.0	5.8	4.6
		p.m.	2.0	2.9	2.4	3.2	4.4	5.8	5.0	5.4
		a.m.	1.2	2.8	3.4	3.2	5.2	6.5	6.5	6.2
		p.m.	1.6	3.4	4.3	3.7	4.2	5.5	5.4	5.2

The figures for both periods are given in table 1. It will be noted the results of both trials check quite closely. Graphs of the milk yeild and the percent of fat of all the cows are given for the first period only.

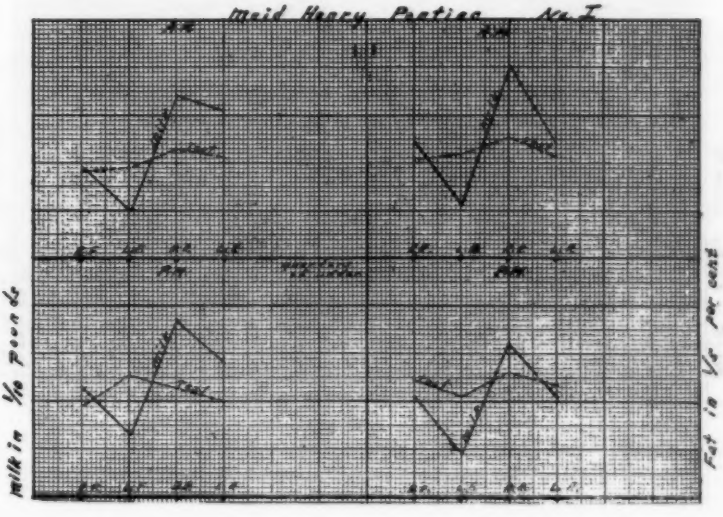
In some cows one certain quarter seemed to presistently test higher or lower in fat then the others. This was especially true of the right fore quarter of cow 5. This quarter was considerably lower in milk than the others.

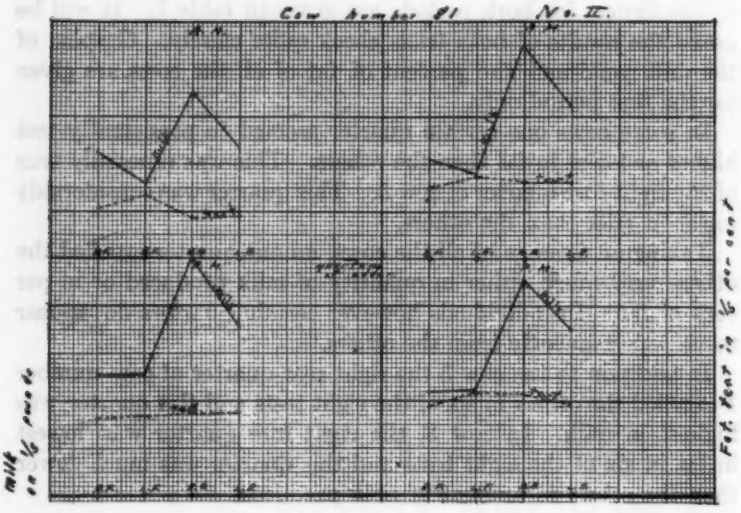
Taking an average of all the cows, no one quarter excelled the others very much either in quantity of milk produced or in per cent of fat. In individuals however certain quarters do appear to vary permanently from the others.

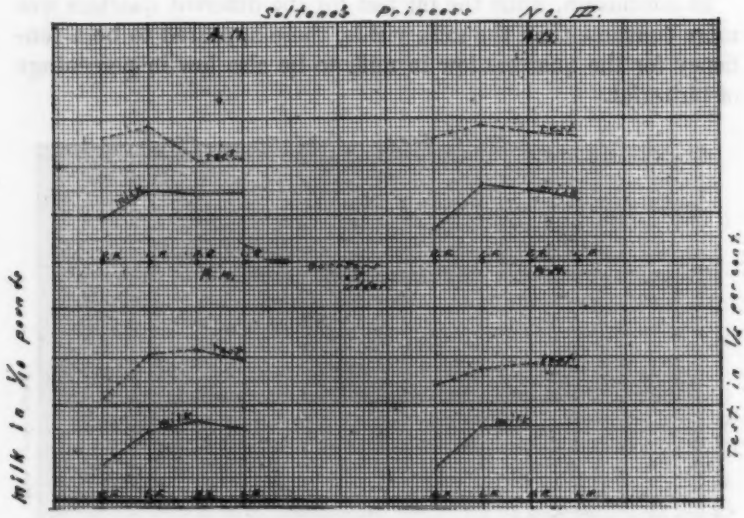
In addition to the cow 5 the right rear quarter of cow number 1 excelled the others in six of the eight tests and this quarter was highest in milk. In cow 3, the right fore quarter was lowest in fat in six of the eight tests and this quarter was much lower than the others in amount of milk produced.

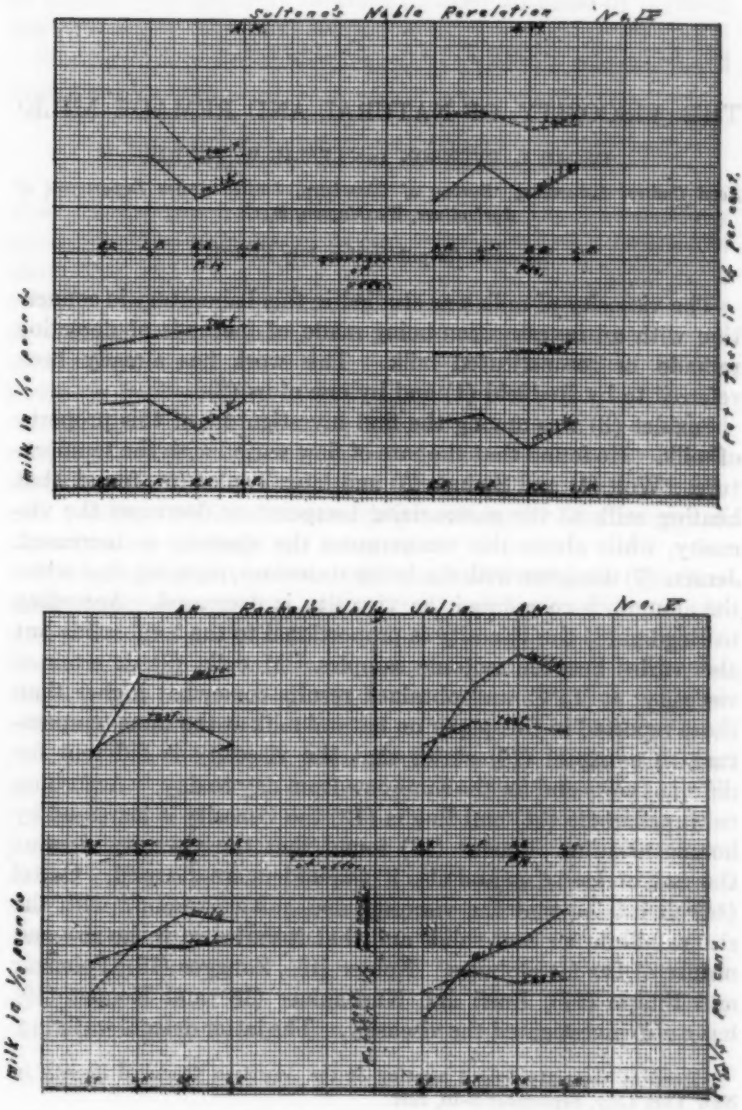
All of the quarters do not vary in fat tests but a few do vary quite noticeably.

In conclusion, while the fat test for the different quarters was more constant than the milk yields, there appeared to be a tendency for the quarters low in milk to be also low in percentage of butterfat.




Cow number 81 No. II.
A.M.
P.M.
Milk in ½ pounds
Fat. test in ½ per cent


Sultana's Princess No. III.
A.M.
P.M.
Milk in ½ pounds
Test in ½ per cent.


Sultana's Noble Revelation No. IV
A.M.
P.M.
milk in ½ pounds
Fat Test in ½ per cent.
A.M. Rachel's Jolly Julia A.M. No. V
milk in ½ pounds
Fat Test in ½ per cent.

THE VISCOSITY OF NATURAL AND REMADE MILK[1]

OSCAR L. EVENSON AND LESLIE W. FERRIS

Food Control Laboratory, Bureau of Chemistry, United States Department of Agriculture, Washington, D. C.

Received for publication July 10, 1923

The viscosity of milk was studied in this Laboratory in connection with an investigation being made of methods of detecting remade or reconstituted milk. This work has already been referred to by Redfield (1) and by one of us (2).

Soxhlet (3) was among the first investigators of this property of milk. He found that the rate of flow varied with the temperature. Woll (4) and Steiner (5) and later Taylor (6), found that heating milk at the pasteurizing temperature decreases the viscosity, while above this temperature the viscosity is increased. Jensen (7) disagrees with the latter statement, claiming that when the albumin is coagulated the viscosity is decreased. According to Bogdan (8) the viscosity is proportional to the total solids but also varies between isotonic samples. Madella (9) determined viscosity at 15°C. and obtained results somewhat higher than those reported in this paper on natural milk at the same temperature. Cavazzani (10) states that the viscosity is different for different cows and for the same cow from day to day. According to Quagliariello (11) and Buglia (12) the viscosity is increased by homogenization. Lucius (13) found that the viscosity rises at the end of lactation and also if the udders are diseased. Oertel (14) maintains that the viscosity does not correspond with the rise or fall in per cent solids and that it varies with the size and nature of the fat globules. Kobler (15), Zangger (16), Polenaar and Fillipo (17), Burri and Nusbaumer (18) and Kooper (19) have also investigated the viscosity. The latter detects watering

[1] Read at the sixty-second meeting of the American Chemical Society in New York City, September 6–10, 1921.

by means of an apparent constant (0.1384) obtained by dividing the viscosity by the total solids.

For the work recorded here the relative viscosity was calculated from the formula;

$$V = \frac{\text{Time of flow of milk} \times \text{specific gravity of milk}}{\text{Time of flow of water} \times \text{specific gravity of water}}$$

The viscosity pipette used is shown in figure 1.[2] The capillary extensions were 10 inches in length. The bulb had a capacity of about 5 cc. and the capillary was of such a size that, using water at 25°C., the pipette drained in about 51 seconds. The water or milk, after adjusting to the desired temperature, was drawn up through the pipette by suction and the time taken for the liquid to flow between points A and B was obtained with a stop watch. The temperature was kept within 0.1° of the desired temperature by circulating water. Variations of as much as 1 second in time of flow occurred in some cases but as a rule duplicate readings within 0.3 second were obtained. The average of three or more readings was taken.

The specific gravity of the milk was calculated from the Quevenne lactometer reading and the per cent total solids was obtained by drying. The acidity of each sample was determined by titration with 0.1 N sodium hydroxide immediately before the viscosity was determined. The peroxidase test was made in two ways as follows: To 10 cc. of milk were added 5 drops of 1 per cent tricresol (20), 5 drops guaiac reagent (4 grams guaiac wood in 50 cc. aceton) and a drop of commercial H_2O_2. To another portion of milk were added 2 drops 1 per cent benzidine in 50 per cent alcohol, 2 drops 1 per cent a-naphthol in 50 per cent alcohol and 1 drop commercial H_2O_2. A blue color develops in the former case and red in the latter, provided the peroxidase has not been destroyed by heat.

Authentic samples of natural milk from herds were obtained and pasteurized at the temperature of about 63°C. for thirty minutes. The milk was then cooled and held at 10–15°C. for

[2] Drawing made by O. S. Rask.

several hours, or over night and used for comparison with remade milk held under the same conditions. Samples of pasteurized market milk were obtained from the local dairies. They were

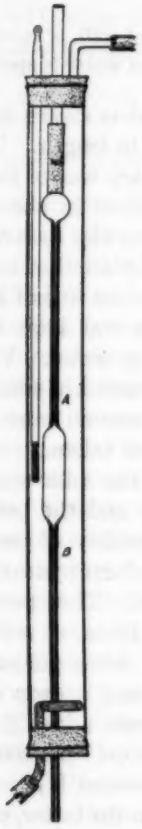


FIG. 1

kept at about 15°C. for at least one hour before determining the viscosity.

Two types of emulsors designated A and B and an homogenizer were used in making the samples of remade milk. In emulsor A

the milk feeds into the bowl from the top and the latter has a speed of 12,000 r.p.m. Emulsor B is what is known as the "suction feed" type, the milk feeding into the bowl from below and the bowl has a considerably higher speed than in the case of emulsor A. The remade milk samples were made from condensed skim milk and unsalted butter, skim milk powder, water and unsalted butter, frozen cream, skim milk powder and water and from whole milk powder, the amounts of the different components being chosen so as to bring the per cent fat and nonfatty solids within the range for natural milk. The milk was pasteurized at about 63°C. for a period of twenty to thirty minutes before it was emulsified. The milk powders were obtained from different manufacturers and were made by several different processes as indicated in tables 3 and 4. In the spray drying process the milk, usually in evaporated form, is sprayed under more or less pressure into a heated chamber, the manner of admitting the hot air and previous treatment of the milk varying with the process used. In the film drying process the milk with or without previous concentration is dried on the surface of one or more steam heated revolving drums. The milk is either sprayed on to the revolving drums or picked up by the latter from below. In some cases the drying cylinders operate under atmospheric pressure and in other cases the cylinders are enclosed in a vacuum chamber and drying is accomplished under reduced pressure.

Superheated condensed skim milk in bulk and frozen cream were obtained from a local ice cream plant and unsalted butter from local distributors.

The temperature at which miik has been held and the length of time it remains at this temperature has considerable effect on the viscosity. A sample of skim milk was pasteurized and divided into two portions. Portion A was kept at 15°C. for one hour and its time of flow through the pipette at 15°C. was 132.7 seconds. Portion B was kept in cold storage for two days at about 3°C. then at 15°C. for one hour and its time of flow was found to be 139.7 seconds. The time of flow as well as the effect of holding whole milk at different temperatures is shown in table 1. A

sample of whole milk was divided into two portions. Portion A was kept at 30°C. for over one hour. Sub-samples were then taken and quickly brought to the desired temperature and the rate of flow was determined at intervals of 5°, from 10° to 40°C. Portion B was kept in cold storage at about 3°C. for one week. Sub-samples of portion B were then treated as in case of portion A. It is seen that the time of flow decreases as the temperature rises and that at 10°C. there is a difference of 13 seconds while at 35°C. there is a difference of only 2.5 seconds in time of flow of two portions of the same sample of milk held at different temperatures.

TABLE 1

Showing difference in time of flow at different temperatures of two portions of the same sample of milk, A held at 30°C. for one hour, B held at 3°C. for one week

	10°C.	15°C.	20°C.	25°C.	30°C.	35°C.	40°C.
A.....	141.9	122.0	106.7	92.1	82.2	72.4	66.1
B.....	155.0	132.6	116.6	96.7	84.4	74.9	
Difference, seconds.....	13.1	10.6	9.9	4.6	2.2	2.5	

TABLE 2

Effect of pasteurization on the viscosity of milk

HEATED 30 MINUTES AT	TIME OF FLOW IN SECONDS AT 20°C.			
	1	2	3	4
35–40°C.	131.6	150.5	129.3	131.0
62–65°C.	130.4	147.8	126.2	129.6
75–80°C.	140.6	154.2		

This change in the viscosity of milk held at different temperatures cannot be attributed to the effect on the fat alone since skim milk also exhibits this phenomenon.[3] The effect of pasteurization on the viscosity of natural milk is shown in table 2. Samples of natural milk were carefully mixed and divided into portions.

[3] While this paper was being prepared for publication a paper on the Chemical and Physical Properties of Remade Milk was published by Palmer and Dahle, Journal of Dairy Science, May 1, 1922, in which results on viscosity are given similar to those reported here.

These portions were heated for thirty minutes at the designated temperatures and any moisture lost by evaporation was replaced with the same weight of distilled water. They were then cooled and held at 17-20°C. for about one hour before the viscosity was determined. It is seen that pasteurization at the ordinary temperature tends to decrease the viscosity slightly. Heating at 75-80°C. for thirty minutes, however, increases the viscosity considerably, this being probably due to a coagulation of the albumin.

A comparison of the viscosity at 25°C. of natural pasteurized milk and remade milk together with mixtures of known amounts of each, is shown in table 3. The relation of viscosity to total solids, the viscosity of water being taken as one, is represented by the expression $\frac{V-1}{T.S.}$ in which V = relative viscosity and T.S. = per cent total solids expressed as parts by weight of milk solids per gram of fluid milk. V–1 represents the viscosity due to the milk solids and is not the same as the relative viscosity of milk. The expression $\frac{V-1}{T.S.}$ gives the same values for skim milk as for whole milk, while the constant of Kooper (21) applies to whole milk only. The samples are arranged in the order of increasing values for $\frac{V-1}{T.S.}$ for remade milk. It is seen that this figure varies between 5.68 and 7.18 for natural pasteurized milk and between 6.26 and 12.60 for remade milk. Figures for the mixtures vary between 5.96 and 8.37. The error in the determination of these figures should not be greater than 0.20. From this table it may be seen that in general there is a certain correlation between the amount of heat to which the milk has been exposed, as indicated by the peroxidase test[4] and the values found for the expression $\frac{V-1}{T.S.}$ in the case of remade milk. As the values for this expression begin to rise somewhat above the maximum value found for natural pasteurized milk, the peroxidase test also

[4] The peroxidase begins to disappear at the temperature of about 72°C.

TABLE 3

Comparison of the viscosity of natural pasteurized milk, remade milk and mixtures of natural and remade milk. Viscosity determined at 25°C.

NATURAL PASTEURIZED MILK				REMADE MILK†					MIXTURES		
Number	Acidity	T.S.	V-1* / T.S.	Acidity	Peroxidase test	T.S.	V-1 / T.S.	Remarks‡	T.S.	Per cent remade	V-1 / T.S.
1	0.14	11.80	5.68	0.15	Positive	12.65	6.26	Spray skim powder (1) and butter			
2	0.15	12.09	6.16	0.12	Positive	11.76	6.37	Spray skim powder (2) and butter	12.00	20.0	6.21
3	0.12	9.10	6.31	0.12	Positive	8.93	6.44	Spray skim powder (2)	9.08	20.0	6.33
4	0.14	12.20	5.97	0.12	Positive	12.60	6.53	Spray skim powder (1) and butter	12.22	15.0	5.96
5	0.14	12.52	6.34	0.15	Positive	12.48	6.59	Spray skim powder (1) and frozen cream	12.44	23.0	6.38
6	0.14	12.57	6.55	0.14	Positive	12.60	6.59	Spray skim powder (1) and butter	12.65	29.2	6.47
7	0.14	12.41	6.34	0.20	Positive	13.85	6.79	Condensed skim milk and frozen cream	12.60	15.0	6.44
8	0.13	12.23	6.70	0.13	Negative	11.75	6.96	Spray skim powder and butter			
9				0.12	Positive	9.44	7.06	Spray skim powder (1)			
10	0.14	12.60	6.19	0.14	Positive	13.40	7.35	Spray whole milk powder (1). Condensed skim milk and frozen cream	12.52	17.1	6.33
11	0.14	12.40	6.37	0.13	Negative	12.52	7.51	Spray skim powder (1) and butter	12.46	25.0	6.74
12	0.12	9.12	6.21	0.12	Negative	8.96	7.76	Spray skim powder	9.04	25.0	6.21
13	0.14	12.15	6.34	0.14	Negative	12.25	7.84	Spray skim powder (5) and frozen cream	12.33	20.0	6.65
14	0.12	12.25	6.35	0.13	Negative	12.42	8.04	Drum skim powder (10) and butter	12.30	15.0	6.42
15	0.11	9.54	6.99	0.11	Positive	9.02	8.06	Spray skim powder (4)	9.38	25.0	7.39
16	0.14	12.20	6.23	0.14	Trace	12.50	8.16	Spray whole milk powder (1)	12.25	25.0	6.61
17	0.14	12.09	6.20	0.13	Trace	12.09	8.19	Spray whole milk powder (1). (Mixing tank)	12.13	15.0	6.51

18	0.12	12.08	6.03	0.14	Negative	11.84	8.20	Spray skim powder (3) and butter	12.21	30.0	6.84
19	0.12	12.39	6.28	0.14	Negative	11.55	8.22	Spray skim powder (3) and butter	11.99	30.0	6.77
20	0.14	9.65	6.74	0.11		9.00	8.50	Spray skim powder			
21	0.13	12.29	6.10	0.19	Positive	15.02	8.65	Condensed skim milk and butter	12.77	17.3	6.44
22	0.13	13.21	6.96	0.13	Negative	12.15	8.81	Spray skim powder and butter			
23	0.13	13.18	7.18	0.14	Negative	11.80	9.19	Spray skim powder (1) and butter			
24	0.11	13.40	6.71	0.13	Negative	11.75	9.30	Spray skim powder (1) and butter. (Homogenized 49°C. and 3000 pounds pressure)	12.72	30.0	8.37
25	0.12	12.90	6.49	0.13	Negative	12.09	9.33	Spray skim powder (5) and butter			
26	0.12	12.46	6.24	0.14	Negative	11.70	9.46	Spray skim powder and butter	12.26	30.0	7.28
27	0.12	12.06	6.22	0.12	Positive	12.55	9.47	Spray whole milk powder (1)	12.16	20.0	6.96
28	0.12	9.16	6.09	0.10	Negative	8.85	9.54	Drum skim powder (9)	9.13	15.0	6.57
29	0.14	11.40	6.44	0.14	Negative	11.30	10.01	Spray skim powder and butter	12.30	20.0	7.07
30	0.12	12.90	6.95	0.07	Negative	12.04	11.83	Drum whole milk powder (11)	12.73	15.0	7.50
31	0.14	12.54	6.14	0.05	Negative	12.59	12.23	Drum skim powder (11) and frozen cream	12.52	20.0	6.95
32	0.20	12.29	6.36	0.05	Negative	12.55	12.60	Drum skim powder (11) and frozen cream	12.44	25.0	7.16

* The viscosity may be calculated from this expression as follows: For natural pasteurized milk No. 1 T.S. = 11.80 and $\frac{V-1}{T.S.} = 5.68$. Then $\frac{V-1}{0.1180} = 5.68$ or V-1 = 0.67 or V = 1.67.

† The samples numbered 7, 11, 13, 16, 21, 31 were made with emulsor B. The remaining samples were made with emulsor A, unless otherwise indicated. The authors are indebted to Dr. H. W. Redfield for his assistance in preparing a number of these samples.

‡ The spray powders were made by two different processes. In case of one process different numbers in parenthesis indicate different manufacturers. In case no number is given, the spray powder was made by a different process, U. S. Patents 1,078,848; 1,107,784; 1,157,935; 1,266,013. In the case of drum powders different numbers in parenthesis indicate different processes.

TABLE 4

Comparison of the viscosity of natural pasteurized milk and remade milk. Viscosity determined at 15°C.

NATURAL PASTEURIZED MILK*				REMADE MILK†					REMARKS
Number	Acidity	T.S.	V-1 / T.S.	Number	Acidity	Peroxidase test	T.S.	V-1 / T.S.	
33	0.13	12.50	7.35	33	0.14	Positive	12.25	7.13	Spray skim powder (7) and butter
36	0.13	12.13	7.42	34	0.13	Positive	12.18	7.43	Spray skim powder (6) and butter
38	0.13	12.42	7.67	35	0.16	Positive	12.98	8.06	Spray skim powder (1) and butter
41	0.13	12.20	7.39	36	0.12	Positive	12.50	8.34	Spray skim powder (1) and butter
42	0.13	12.42	7.26	37	0.12	Positive	9.18	8.44	Condensed skim milk
44	0.13	11.86	7.35	38	0.13	Positive	12.27	8.76	Spray skim powder (4) and butter. (Homogenized at 44°C. and 2500 pounds pressure)
45	0.15	12.14	7.20	39	0.13	Positive	12.90	8.92	Spray whole milk powder (1). (Homogenized at 50°C. and 2500 pounds pressure)
46	0.12	13.11	7.32	40	0.14	Positive	9.24	9.17	Dough process skim powder. (Mixing tank)
				41	0.11	Positive	12.40	9.19	Spray skim powder (1) and butter. (Homogenized at 48°C. and 2500 pounds pressure)
MARKET MILK									
60	0.13	11.97	6.78	42	0.15	Positive	12.50	9.38	Spray whole milk powder (1)
61	0.14	10.50	7.03	43	0.16	Trace	11.98	9.52	Condensed skim milk and butter
62	0.14	12.56	7.43	44	0.12		12.06	9.65	Spray skim powder and butter
63	0.14	12.36	6.96	45	0.08	Positive	11.85	10.26	Drum process skim powder (11) and butter
64	0.16	12.48	6.70	46	0.13	Negative	12.10	11.70	Spray skim powder (8) and butter
65	0.14	12.05	6.78	47	0.09	Negative	11.95	13.90	Drum whole milk powder (11)

66	0.13	12.75	7.11	48	0.07	Negative	12.13	16.07	Drum whole milk powder (12)
67	0.13	12.05	7.11	49	0.11	Negative	12 48	16 63	Drum whole milk powder (13)
68	0.14	12.11	6.99						
69	0.14	12.60	7.36						
70	0.17	11.97	7.18						
71	0.14	12.05	6.95						
72	0.14	12.25	7.36						
73	0.14	12.30	7.32‡						
74	0.14	11.68	7.69						
75	0.14	12.15	7.40						
76	0.15	11.95	6.89						
77	0.13	12.14	7.40						
78	0.15	13.26	7.63‡						
79	0.14	12.68	8.06‡						

* These samples were strained through cheese cloth. The market milk samples were not strained.

† Emulsor A was used in making these samples unless otherwise indicated. In the case of spray powders, different manufacturers using the same general process are indicated by different numbers in parenthesis. In case no number is given (no. 44) the powder was made by a different process. See last note table 3. In case of drum powders different numbers in parenthesis indicate different processes.

‡ Raw milk.

becomes negative. However in the case of no. 8 a negative peroxidase test is accompanied by a low viscosity. No reason can be assigned for this discrepancy nor for the high viscosity accompanying a positive peroxidase test in the case of sample 15. In respect to samples 16, 17 and 27 the high values for $\frac{V-1}{T.S.}$ are to some extent due to the homogenizing effect on the fat of the high pressure used in the process of manufacture of the powder. The results obtained for the mixtures given in this table, with the exception of no. 24, differ to a small extent only from those obtained for natural pasteurized milk, the difference being either within the range of experimental error or within the range of variation found for natural milk. It is apparent therefore that a determination of the viscosity would be of little use in detecting mixtures of natural pasteurized milk and remade milk in proportions such as recorded here. In the samples of remade milk shown in this table for which the values for $\frac{V-1}{T.S.}$ are within the range found for natural pasteurized milk, the colloidal condition of the powder has apparently not been changed in the process of manufacture in so far as it affects the viscosity. The high viscosity shown by remade milk made from some drum and spray powders is apparently due to the high heat to which the powders have been exposed in the process of manufacture which tends to coagulate the albumin and make the powder dissolve with more or less difficulty.

In table 4 a comparison is shown of the viscosity figures obtained at 15°C. for natural and remade milk. Here similar relations are shown as in table 3, the values for $\frac{V-1}{T.S.}$ however being higher due to the lower temperature used in determining the viscosity. As in table 3 the high viscosity shown by remade milk samples 38, 39, 41 and 42 is partly due to homogenization while in the case of samples 45, 47 and 48 the abnormally low acidities probably to some extent influence the viscosity. The positive peroxidase test given by samples 40 and 45 indicates that the powders used have not been exposed to a high degree

of heat. A determination of the albumin in these two samples showed that little or no coagulation had taken place.

TABLE 5

Showing effect of the emulsor and homogenizer on the viscosity of natural and remade milk

Viscosity determined at 25°C.

NUMBER		$\frac{V-1}{T.S.}$
	Natural pasteurized milk	
50	Natural pasteurized milk	7.09
50	Above homogenized at 43.3°C. and 3500 pounds pressure	10.64
56	Natural pasteurized cream*	9.22
56	Above homogenized at 43.3°C. and 1200 pounds pressure	49.10
54	Natural pasteurized milk	6.84
54	Above homogenized at 43.3°C. and 1200 pounds pressure	7.09
55	Natural pasteurized milk	6.30
55	Above emulsified, emulsor A	7.17
26	Natural pasteurized milk	6.24
26	Above emulsified, emulsor B	6.46
2	Natural pasteurized milk	5.94
2	Above emulsified, emulsor B	5.86
	Remade milk†	
50	Condensed skim milk and butter, homogenized at 41.6°C. and 3500 pounds pressure	16.65
51	Condensed skim milk, frozen cream homogenized at 43.3°C. and 3500 pounds pressure	14.95
21	Condensed skim milk and butter, emulsor A	8.65
7	Condensed skim milk and frozen cream emulsor A	6.79
52	Spray skim powder (5) and butter, homogenized at 43.3°C. and 1200 pounds of pressure	8.18
53	Spray skim powder (5) frozen cream, homogenized at 42.7°C. and 1200 pounds pressure	9.56
5	Spray skim powder (1) and frozen cream emulsor B	6.59
6	Spray skim powder (1) and butter, emulsor B	6.59
54	Drum skim powder (11) and butter, homogenized at 43.3°C. and 1200 pounds pressure	13.51
55	Drum skim powder (11) and butter emulsor A	12.95
31	Drum skim powder (11) and frozen cream, emulsor A	12.23
32	Drum skim powder (11) and frozen cream, emulsor B	12.60

* 19.24 per cent fat.

† Figures in parenthesis indicate different manufacturers.

The effect of the emulsors and homogenizer on natural pasteurized milk and remade milk is shown in table 5. Homogenization at 3500 pounds pressure increases considerably the viscosity of milk as well as cream. A pressure of 1200 pounds also increases the viscosity of cream considerably, but seemed to increase the viscosity of milk to a small extent only. The emulsor increases the viscosity of milk slightly or not at all.

The effect of putting natural and remade milk through a high speed centrifuge[5] (30,000 r.p.m.) on the relation of viscosity to

TABLE 6

Effect of high speed centrifuge on relation of viscosity to total solids

NUMBER	ORIGINAL	SKIMMED ONCE	SKIMMED TWICE	SLIME FROM BOWL
	$\frac{V-1}{T.S.}$ on natural pasteurized milk			
11	6.37	6.13	5.21	6.07
32	6.36	5.81	4.82	6.07
5	6.34	6.39	5.66	8.53
6	6.55	6.47	5.55	7.94
	$\frac{V-1}{T.S.}$ on remade milk			
11	7.51	7.98	5.56	
32	12.60	12.94	9.06	
5	6.59	6.51	4.92	12.66
6	6.59	5.28		

* The composition of these samples is given in table 3.

total solids, $\frac{V-1}{T.S.}$ is shown in table 6. Column 2 in this table, shows the values obtained on the original milk. This milk was then run through the centrifuge and the values obtained on the skim milk, which are shown in column 3. This skim milk was then run through the centrifuge again. The figures obtained on the second skim milk are given in column 4. From table 6 it may be seen that there is practically no change in the relation

[5] This centrifuge differs from a cream separator mainly in the speed of the bowl.

of viscosity to the solids when milk is skimmed once, but the second skimming appears to change the composition of the skim milk by removing milk solids so that the values for $\frac{V-1}{T.S.}$ are lowered. This is more marked in the case of remade milk. Considerable difference was noted in the sediment left in the bowl of the centrifuge. The sediment from the natural milk was easily mixed with water and had a viscosity only slightly greater than that of the original milk. The sediment from the remade milk, however, besides being larger in amount, was packed against the side of the bowl in a hard, bony mass and in one case only could the sediment be mixed with water and its viscosity determined.

SUMMARY

The relation of viscosity to the total solids is shown by means of the expression $\frac{V-1}{T.S.}$ in which

$$V = \frac{\text{Time of flow of milk} \times \text{specific gravity of milk}}{\text{Time of flow of water} \times \text{specific gravity of water}}$$

and T.S. = total solids expressed as parts by weight of milk solids per gram of fluid milk. For a given number of samples the values for $\frac{V-1}{T.S.}$ for natural pasteurized milk varied from 5.68 to 7.18 and for remade milk from 6.26 to 12.60 at 25°C. The figures for mixtures containing 15 to 30 per cent of remade milk varied from 5.96 to 8.37. When the viscosity was determined at 15°C. the figures varied from 7.20 to 7.67 for natural pasteurized milk, from 6.70 to 8.06 for market milk and from 7.13 to 16.63 for remade milk.

The viscosity of milk as determined is, to a certain extent, dependent upon the temperature at which the milk has been held.

The viscosity is decreased slightly by pasteurization at 62–65°C. for 30 minutes, but considerably increased by heating at 75–80°C. for the same length of time.

Homogenization at a high pressure has considerable effect on the viscosity, while the emulsor has little or no effect.

By means of a high speed centrifuge it was found possible to throw out milk solids from both natural and remade milk to such an extent as to lower the values for $\frac{V-1}{T.S.}$ as compared with the values for the original milk. The sediment obtained from remade milk differed in quantity and character from that of natural milk.

REFERENCES

(1) REDFIELD: Contribution made at Conference of the Int. Assn. Dairy and Milk Insprs., April 26, 1919.
(2) EVENSON: 10th Ann. Rept. Int. Assn. Dairy and Milk Insprs., 1921.
(3) SOXHLET: Landw. Vers., xix, 1876, 143.
(4) WOLL: Wis. Exp. Sta., 12th Ann. Rept., 1895.
(5) STEINER: Milch Ztg., xxx, 1901, 401.
(6) TAYLOR: Jour. Proc. Roy. Soc. N. S. W., xlvi–xlvii, 1912–14, 174.
(7) JENSEN: Milchw. Zentbl., xli, 1912, 712.
(8) BOGDAN: Ann. Chimi. Analyt., x, 1905, 90.
(9) MADELLA: Staz. Sperim. Agrar. Ital., xxxvii, 1904, 383.
(10) CAVAZZANI: Zentbl. Physiol., xviii, 1905, 84.
(11) QUAGLIARIELLO: La Pediatria, xxiv, no. 8.
(12) BUGLIA: Koll. Zeit., ii, 1907–08, 355.
(13) LUCIUS: Chemi. u. Physiol. der Milch, Grimmer.
(14) OERTEL: Diss. Leipzig, 1908; Abst. Milchw. Zentbl., vii, 1911, 137.
(15) KOBLER: Arch. Ges. Physiol., cxxv, 1908, 1.
(16) ZANGGER: Schw. Arch. Tierheilk., 50, 50, 1908.
(17) POLENAAR AND FILLIPO: Zeit. f. Experim. Pathol., ix, 1911, 138.
(18) BURRI AND NUSBAUMER: Biochem. Zeit., xxii, 1909, 90.
(19) KOOPER: Milchw. Zentbl., xliii, 1914, 169, 201.
(20) KASTLE AND PORCH: Jour. Bio. Chem., iv, 1908, 301.
(21) KOOPER: Loc. cit.

THE RELATION BETWEEN AGE AND FAT PRODUCTION IN DAIRY COWS

ARTHUR C. RAGSDALE, CHARLES W. TURNER AND SAMUEL BRODY

Department of Dairy Husbandry, University of Missouri, Columbia, Missouri

Received for publication October 1, 1923

Milk secretion, like other physiological processes changes with age in a definite way. It was observed at an early date that milk and fat production, on the average gradually increases as the dairy cow becomes mature and then gradually decreases with the onset of old age; thus under similar conditions of feeding and management a heifer is expected to increase her yearly production at each succeeding lactation period until she reaches maturity.

There has been, however, more or less uncertainly among breeders of dairy cattle as to the age of maturity and maximum milk and fat production. The rate of increase of production with each succeeding year and lactation is also a debated question.

At the time of the adoption of the advanced registry system by the several dairy cattle breed associations, accurate data were not available and therefore arbitrary minimum requirements for entrance varying from 250.5 pounds of fat at two years to 360 pounds of fat at five years were established. While these requirements were arbitrary and not based on data, they have been widely accepted by dairymen as indicating that milk secretion increases in a linear manner and that maximum production was reached by the time the dairy cow was five years old.

Since the inauguration of the advanced registry system in this country many thousands of yearly and seven-day records have been completed and reported in the herd books of the several breed associations. The records furnish excellent data to determine the relation between age and milk secretion throughout the entire productive life of the dairy cow.

Pearl and co-workers (1) at the Maine Station made use of a limited number of records in showing that the curve relating milk flow to age in dairy cattle was generally of logarithmic form. Hooper (2) of the Kentucky Station and McCandlish (3) of the Iowa Station have also presented a limited amount of data showing the relation between age and production.

The data presented by these workers being rather limited, it was thought worth while to compile all the available data. With the coöperation of the advanced registry departments of the several breed associations, it has been possible to secure practically all the fat production records made in this country previous to the recent changes in the minimum requirements.

In making a study of these records, it was realized that the records are of a selected population. In the first place the minimum entrance requirements eliminate all animals incapable of meeting this standard. In the second place, the cows of advanced ages are also more or less selected, as only cows of exceptional ability as producers would be tested at advanced ages, and due to the declining productive ability as they grow old they enter the advanced registry with increasing difficulty. These shortcomings must be kept in mind in interpreting and in making use of these data.

In table 1 are presented the results of a study of over 46,000 yearly records and over 104,000 seven-day records classified by age intervals of one year. As will be seen from figure 1 the age of maximum production varies but slightly between the several breeds and does not appear to be significant. It will be seen that fat production gradually increases up to between seven and eight years of age on the average, and then gradually decreases with the onset of old age. The minimum requirements are also plotted, beings raised 100 pounds for convenience of comparison. It will be seen from the difference in the slope of the two curves that up to eight or nine years of age the older the cow the easier it is for her to exceed the minimum requirements, but that after that age animals are at a constantly increased handicap due to the effect of old age on production.

TABLE 1

The relation between age and yearly feed production of dairy cattle

AGE	AYRSHIRE COWS		GUERNSEY COWS		HOLSTEIN COWS				JERSEY COWS		MILKING SHORTHORN COWS		WEIGHTED AVERAGE OF ALL COWS		FAT EXPRESSED AS PER CENT OF MAXIMUM PRODUCTION	SEVEN DAY RECORDS	
					365 day records		305 day records										
	Number of cows included	Fat per year	Number of cows included	Fat per year	Number of cows included	Fat, 365 days	Number of cows included	Fat, 305 days	Number of cows included	Fat, 365 days	Number of cows included	Fat per year	Number of cows included	Average yearly fat production		Number of animals	Pounds of fat
years		*pounds*		*pounds*		*pounds*		*pounds*		*pounds*		*pounds*		*pounds*			
1.7			313	368					947	353	15	252	1,275	355.4	64.6	33,765	12.46
2.5	1,710	350	5,241	412	2,454	508	1,250	413	4,090	383	306	272	15,001	404.9	73.6	22,019	14.91
3.5	903	378	2,566	452	1,523	570	762	475	2,263	443	167	285	8,184	462.0	84.0	16,374	16.20
4.5	716	418	1,977	492	1,238	615	606	493	1,687	486	125	352	6,349	497.1	90.4	11,259	17.39
5.5	545	448	1,133	511	1,116	644	467	513	1,487	502	75	376	4,823	424.7	95.5	8,356	17.26
6.5	399	455	897	521	835	666	331	544	1,067	516	80	383	3,609	544.8	99.1	5,586	17.32
7.5	298	478	572	528	583	665	223	547	837	521	66	405	2,579	549.4	100.0	3,256	17.25
8.5	225	453	369	527	396	659	156	566	565	524	65	402	1,776	544.9	99.1	1,862	17.19
9.5	155	454	264	524	232	654	72	541	355	510	43	403	1,121	533.2	97.0	1,054	16.80
10.5	100	472	123	512	111	652	46	529	200	509	29	411	609	526.4	95.8	548	16.34
11.5	52	423	76	486	59	650	17	538	108	513	21	369	333	507.9	92.4	285	15.96
12.5	26	450	32	500	37	595	13	441	58	453	13	397	179	485.3	88.3	130	15.54
13.5	15	436	24	447	11	569	6	510	31	470	4	399	91	469.8	85.5	42	15.04
14.5	8	375	5	491	4	550			13	447	3	360	33	440.7	80.2	24	15.41
15.5	4	392	4	446	4	475			8	451	2	353	22	434.8	79.1	16	15.43
16.5	2	458	1	395	2	500			5	465			10	463.6		4	18.37
17.5	2	376	2	410					1	590			5	432.4		3	15.50
18.5	1	411							1	413			2	412.0			
19.5	0												0				
20.5	1	375											1	375.0			
	5,162		13,599		8,605		3,949		13,723		1,014		46,002			104,583	

* Compiled from the records of *Register of Merit* Jersey, *Record of Merit* Shorthorn, *Advanced Register* Ayshire, Guernsey and Holstein cattle.

Total number of cows included in this table 195,678.

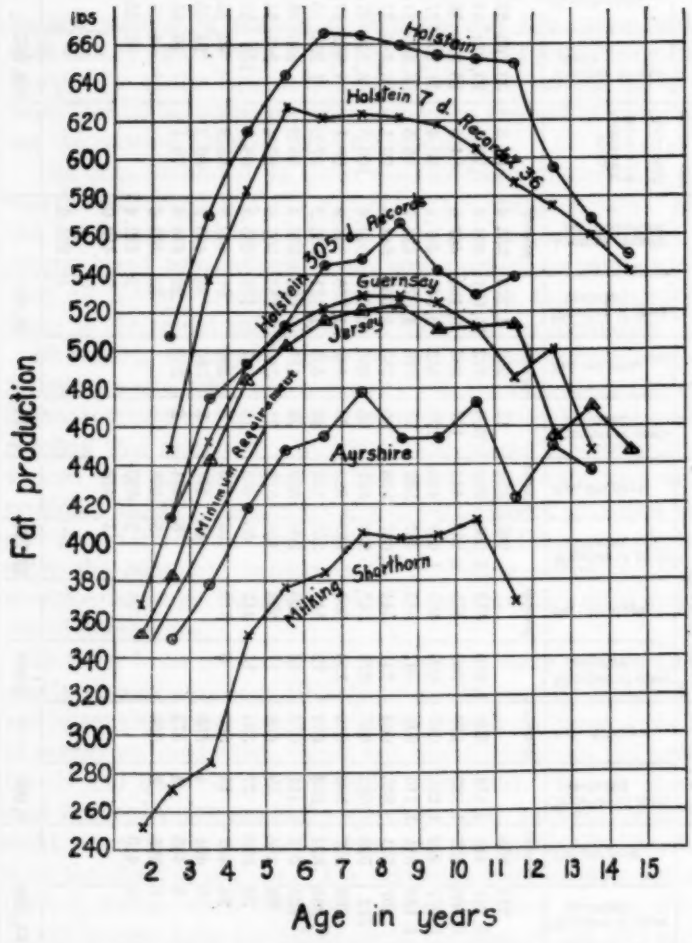


FIG. 1. THE RELATION BETWEEN AGE AND FAT PRODUCTION IN DAIRY CATTLE

With the exceptions noted the curves represent the butterfat production on yearly test. The minimum requirements are raised 100 pounds for convenience of comparison.

In figure 2 the weighted average production of all breeds on yearly test is plotted in terms of the percentage of the maximum production. By means of this chart one can easily determine what may be expected of a dairy cow at various ages in relation to her maximum production. In a previous paper (4) the course

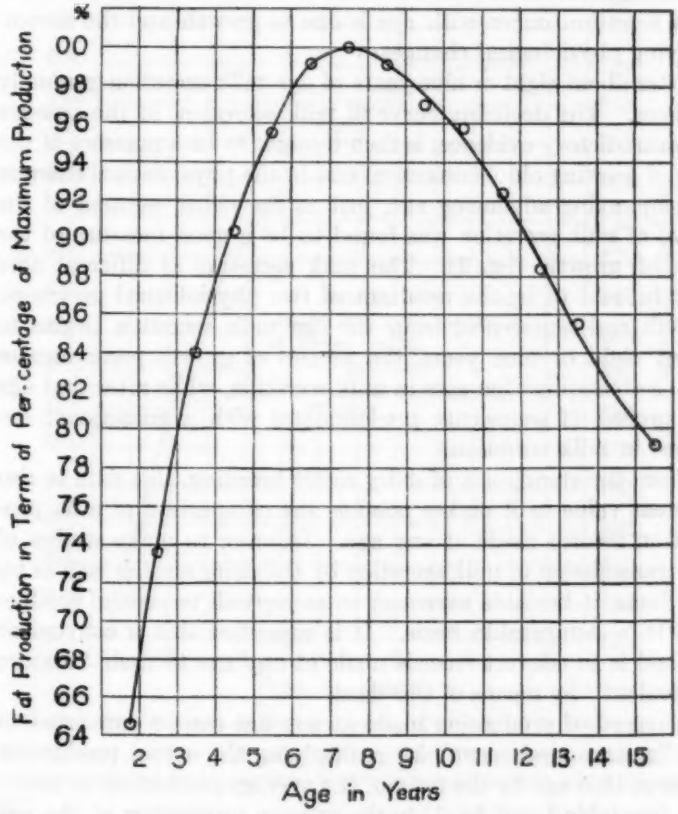


FIG. 2. THE RELATION BETWEEN AGE AND FAT PRODUCTION EXPRESSED AS PERCENTAGE OF MAXIMUM PRODUCTION

This curve represents over 45,000 yearly records including practically all official records of the Ayrshire, Guernsey, Holstein, Jersey, and milking Shorthorn breeds.

of growth with age on lactating Jerseys was presented. It was shown that the Jersey cow increases in body weight with age up to about eight years. A comparison of these data (fig. 3) shows that growth in weight and increase in milk secretion of the Jersey cow follows the same course up to the time of maturity. It is inferred from this close relation that the upward trend of the milk secretion curve with age is due to growth and the accompanying physiological changes.

After about eight or nine years of age milk secretion gradually declines. The declining curve of milk secretion, in the absence of contradictory evidence, is then thought to be a measure of the rate of growing old (senescence) and of the physiological changes accompanying advancing age, just as the rising segment of the curve of milk secretion was found to be a good measure of the rate of growth (fig. 3). The milk secretion at different ages may be said to be the resultant of two physiological processes, growth and senescence; from the age milk secretion begins to about eight or nine years, the process of growth predominates with a consequent increase in milk secretion, while after that age the process of senescence predominates with a consequent decrease in milk secretion.[1]

From the standpoint of dairy cattle breeding, this data is also of great value as it makes possible the comparison of milk production records made at any age. In order to make studies of the transmission of milk secretion by the dairy sires as well as by the dams, it becomes necessary to convert all records of production to a comparable basis. It is suggested that a convenient method is to convert records made at any age to their "mature equivalent" by means of this data.

A record of production made at any age can be converted to the "mature equivalent" by multiplying the actual production made at that age by the ratio of the average production at maturity (see table 1 and fig. 1) to the average production at the age the record in question was made.

The following example will illustrate the method. If a cow at four and one-half years produces 624 pounds of fat, what is

[1] Certain theoretical considerations of this problem are presented in the Jour. of Gen. Physiol. vol. vi, September, 1923.

her "mature equivalent" record? The weighted average fat production of all breeds at four and one-half years is 497.1 pounds of fat and at maturity, 549.4 pounds of fat (see table 1) therefore:

$$624 \times \frac{549.4}{497.1} = 689.6 \text{ pounds of fat (mature equivalent).}$$

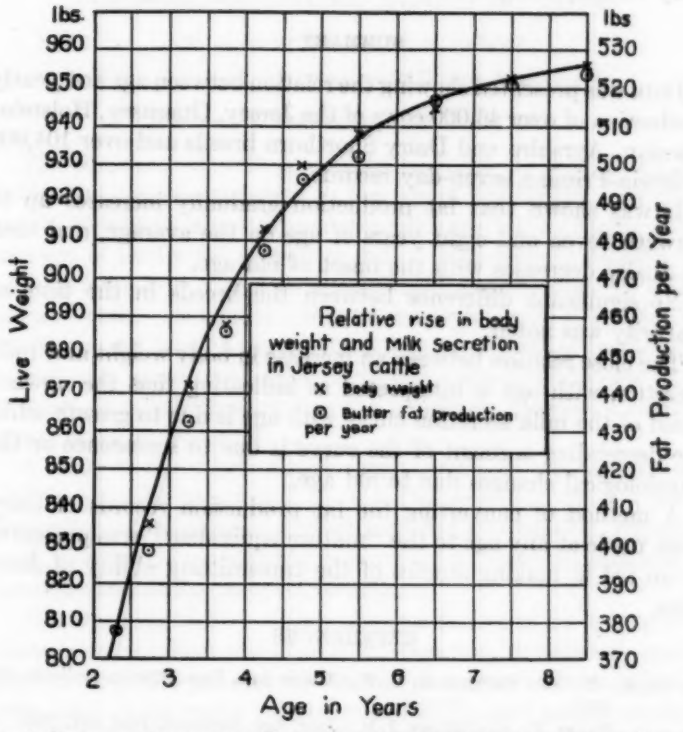


FIG. 3. RELATIVE INCREASE IN WEIGHT AND FAT PRODUCTION IN JERSEY CATTLE

The increase of body weight with age is indicated by the crosses and the fat production indicated by the circles. It will be noted that both follow the same course.

In other words, a cow capable of producing 624 pounds of fat at four and one-half years of age, under similar conditions of feeding and management may be expected to produce 689.6 pounds of fat at maturity.

The records of production of each of the dairy breeds may be converted by this method, using the data of that particular breed.

Studies on the transmitting ability of the sires of each of the dairy breeds, using the above method, are now in progress.

SUMMARY

Data was presented showing the relation between age and yearly production of over 46,000 cows of the Jersey, Guernsey, Holstein-Friesian, Ayrshire and Dairy Shorthorn breeds and over 104,000 Holstein-Friesian seven-day records.

It was shown that fat production gradually increases up to between seven and eight years of age on the average, and then gradually decreases with the onset of old age.

No significant difference between the breeds in the time of maturity was noted.

The close relation between an increase in body weight and milk secretion with age is interpreted as indicating that the upward trend of the milk secretion curve with age is due to growth while the descending segment of the curve is due to senescence or the physiological changes due to old age.

A method of converting the fat production records of dairy cows made at any age to the "mature equivalent" was presented as an aid in making studies of the transmitting ability of dairy sires.

REFERENCES

(1) Pearl, R., and Patterson, S. W.: Maine Agr. Exp. Station Bulletin 262, 1917.
Pearl, R., and Miner, J. R.: Jour. Agr. Research, 1919, xvii, 285.
Pearl, R., Gowen, J. W., and Miner, J. R.: Ann. Rept. Maine Agr. Sta., 1919, 89.
Gowen, J. W.: Genetics, 1920, v, III.
Gowen, J.: Ann. Rept. Maine Agr. Exp. Sta., 1920, 185.
(2) Hooper, J. J.: Kentucky Agr. Exp. Sta. Bul. 234, 1921.
(3) McCandlish, A. C.: Iowa Agr. Exp. Sta. Research Bul. 73, 1922.
(4) Turner, C. W., Ragsdale, A. C., Brody, S.: Jour. Dairy Sci., vi, no. 5, September, 1923.

THE EFFECT OF MILK PLANT OPERATIONS ON THE AMOUNT OF CREAM RISING ON MILK[1]

W. H. MARTIN AND W. B. COMBS

Dairy Husbandry Department, State College, Pennsylvania

Received for publication November 25, 1922

The consumer of milk is inclined to judge its richness by the volume of cream appearing in the top of the bottle. Unfortunately, this basis of measurement is not a reliable indication of the amount of butter fat present in milk. It is entirely possible for milk to contain the legal fat requirement and yet show no cream in the bottle. Seldom is this true, however, upon milk which is produced and bottled on the farm, but when milk is transported to the milk plant and subjected to the various treatments given it there, it more often reaches the consumer showing a reduced cream layer in the bottle.

A study of the effect of milk plant operations on the creaming ability of milk was made at the Pennsylvania State College Creamery. The factors studied included clarification, pumping cold and hot milk, agitating hot milk, and different methods of heating and cooling pasteurized milk.

The creaming ability of the milk was measured by taking duplicate samples before and after each operation, in cylinders graduated to read the per cent by volume of cream. These cylinders were held at ice water temperature (35°F.) and hourly readings were taken for twenty-four hours. Unless otherwise stated the last readings are used in making a summary of the results.

I. THE EFFECT OF CLARIFICATION

Milk at 55°F. was clarified by passing it through a DeLaval centrifugal clarifier. Samples of milk were taken before and

[1] Submitted by W. H. Martin in partial fulfillment of the requirements for the degree of Master of Science at the Pennsylvania State College.

after clarification for cream line readings. Similar tests were made with milk clarified at 90°F., and with milk clarified at 55°F. and heated at 90°F. after clarification.

TABLE 1

TRIAL	PER CENT VOLUME OF CREAM ON					
	Unclarified	Clarified 50°F.	Unclarified	Clarified 90°F.	Unclarified	Clarified, heated to 90°F.
1	15	14	15	15	17	17
2	17	16	14	14	16	16
3	16	14	17	16	15	15
4	20	15	16	17	15	14
5	17	15				
6	19	16				
7	18	16				
8	19	16				
Average.....	17.6	15.25	15.5	15.5	15.75	15.5

II. EFFECT OF PUMPING HOT AND COLD MILK

Cold milk was pumped from the clarifier to the pasteurizer. Samples were taken before clarification, after clarification and from the discharge of the pump. Trials were also run in which milk was pasteurized, and half of it was pumped while hot over a cooler, where it was cooled to 50°F.; the other half was allowed to flow by gravity over the cooler. Samples were taken of the

TABLE 2

TRIAL	PER CENT VOLUME OF CREAM RISING ON MILK		
	Unpumped raw	Unpumped clarified	Clarified and pumped
1	15	14	15
2	17	16	16
3	16	14	13
4	17	15	17
5	17	15	17
6	17	16	16
7	17	15	16
Average.....	16.57	15	15.71

milk before pasteurization and of the pumped and unpumped pasteurized milk after it was cooled.

TABLE 3

TRIAL	PER CENT VOLUME OF CREAM RISING ON MILK		
	Raw	Pasteurized and pumped	Pasteurized not pumped
1	17.0	17.0	17.0
2	16.0	15.0	16.0
3	16.0	13.5	15.0
4	16.0	15.5	16.5
5	16.0	16.0	16.5
6	17.0	17.0	17.0
7	17.0	17.0	18.0
Average.....	16.4	15.7	16.6

III. LENGTH OF TIME OF HOLDING IN THE PASTEURIZER WITH AGITATION

In market milk plants it is often necessary to hold the pasteurized milk for some time before it is cooled. A study was made of this factor in order to determine how long the milk could remain in the pasteurizer while hot and subject to agitation, without affecting the creaming ability of milk.

Observations were made on milk held in the pasteurizer while hot for different periods of time. Samples were taken hourly and the volume of cream that came to the surface was recorded The results of four trials are indicated below by means of the chart.

IV. EFFECT OF PASTEURIZATION AND METHOD OF COOLING ON CREAM LINE OF MILK

Trials were made in which milk was pasteurized and part was cooled in the vat, and part cooled quickly by passing the milk over a surface cooler as soon as the holding period was over. A comparison was made with other pasteurizers by pasteurizing part of the milk in each machine. The results of these trials are recorded in the following table.

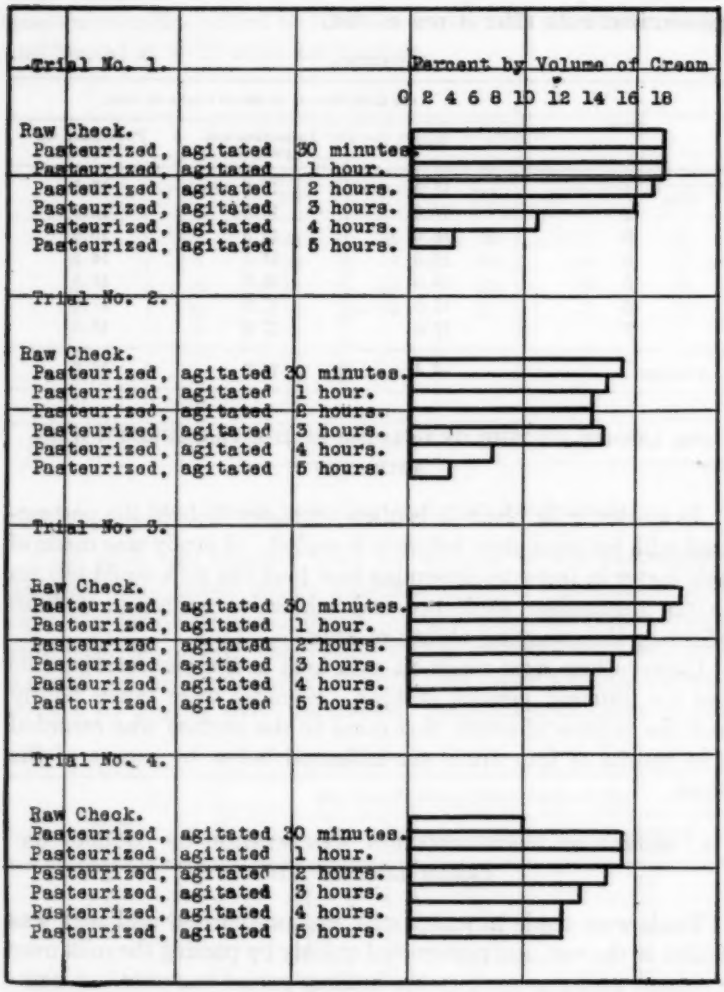

Trial No. 1.
Percent by Volume of Cream
0 2 4 6 8 10 12 14 16 18
Raw Check.
Pasteurized, agitated 30 minutes.
Pasteurized, agitated 1 hour.
Pasteurized, agitated 2 hours.
Pasteurized, agitated 3 hours.
Pasteurized, agitated 4 hours.
Pasteurized, agitated 5 hours.
Trial No. 2.
Raw Check.
Pasteurized, agitated 30 minutes.
Pasteurized, agitated 1 hour.
Pasteurized, agitated 2 hours.
Pasteurized, agitated 3 hours.
Pasteurized, agitated 4 hours.
Pasteurized, agitated 5 hours.
Trial No. 3.
Raw Check.
Pasteurized, agitated 30 minutes.
Pasteurized, agitated 1 hour.
Pasteurized, agitated 2 hours.
Pasteurized, agitated 3 hours.
Pasteurized, agitated 4 hours.
Pasteurized, agitated 5 hours.
Trial No. 4.
Raw Check.
Pasteurized, agitated 30 minutes.
Pasteurized, agitated 1 hour.
Pasteurized, agitated 2 hours.
Pasteurized, agitated 3 hours.
Pasteurized, agitated 4 hours.
Pasteurized, agitated 5 hours.

CHART 1

The results obtained in this experiment showed that there is a reduction of 30, 38, and 60 per cent in the volume of cream which formed on milk pasteurized and cooled in the glass lined vat as compared with the volume of cream rising on raw milk. The loss amounted to 7, 8 and 15 per cent, when the cooling was done by passing the milk over a cooler as soon as the holding period was over. When the same milk was pasteurized and cooled in a pasteurizer of the coil vat type the loss was 8, 14 and 15 per cent; when cooled over a cooler the loss was 3 and 7 per cent in two trials and a gain of 8 per cent in one trial.

TABLE 4

	PASTEURIZER					
	Coil vat			Glass lined vat		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Temperature of raw milk °F.....	65	68	68	65	68	68
Time in minutes required to heat to 142°F.....	32	23	43	18	17	22
Time in minutes held at 142°F....	25	25	25	25	25	25
Time in minutes to cool to 50°F..	55	90	75	130	120	110
Per cent fat.....	3.8	3.7	3.9	3.8	3.7	3.9
Per cent by volume of cream rising on raw milk.....	12	13	14	12	13	13
Per cent of cream rising on milk cooled quickly over cooler.....	13	13½	13	11	11	12
Per cent of cream rising on milk cooled slowly in vat.....	11	11	12	8	5½	9

The method of cooling milk and the agitation it is subjected to during pasteurization, holding and cooling seems to play an important part in the creaming ability of milk. When cooling was done in the vat, the cream line was materially effected. The amount of decrease was influenced by the amount and kind of agitation to which the milk was subjected. This loss can be over come by cooling the milk quickly without agitation.

It is the common belief that the creaming ability of milk is affected by some mechanical effect upon the fat globules themselves. It is generally believed that by breaking up the fat globules a reduction in cream layer results. The results submitted

in this paper showing the effect of agitating hot milk upon the cream layer of milk might indicate that this agitation affected the size of the fat globules and the result was a reduced cream layer.

Preliminary trials upon separated milk, agitating for several hours first the cream and then the skimmilk and recombining to the original percentage indicated that the agitation apparently had but little effect when exerted on the cream, but when exerted on the skimmilk resulted in very noticeable decreases in the cream layer.

TABLE 5

Volume of cream rising on pasteurized milk made from viscolized cream and untreated skim milk

TREATMENT	TEMPERATURE	PER CENT OF TOTAL VOLUME APPEARING AS CREAM HOURLY AFTER SETTING											
		1 hour	2 hours	3 hours	4 hours	5 hours	6 hours	8 hours	10 hours	12 hours	14 hours	16 hours	18 hours
Raw milk before separation, 4 per cent fat	50	10	11	11	11	11	11	12	12	12	13	13	14
	35	10	13	18	21	21	21	21	21	21	21	20	20
Pasteurized milk made from 45 per cent cream viscolized 2500 pounds pressure 4 per cent fat	50	10	25	26	26	26	25	25	24	24	23	22	22
	35	0	0	31	31	31	31	30	29	29	29	28	27

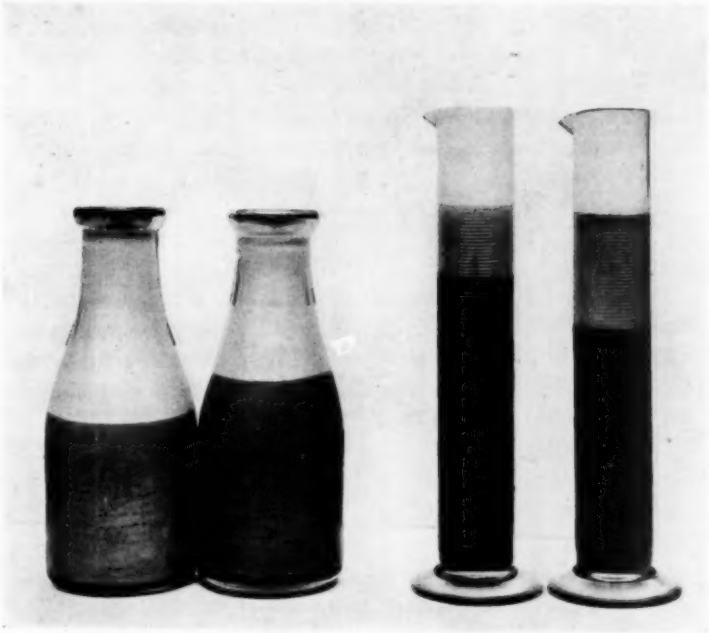
In the minds of the authors these results combined with those mentioned above indicate that it is not the fat of milk so much as it is the solids carried in the serum, which are affected by milk plant operations and which when acted upon mechanically bring about variations in the creaming ability of milk.

To corroborate these results a sample of milk was viscolized at 2000 pounds pressure and its creaming ability compared with a check sample. The volume of cream rising on the raw milk was 10 per cent, while that on the viscolized milk was 2 per cent.

Milk testing 4 per cent was then separated and the cream viscolized at 2500 pounds pressure before reconstructing. The results are indicated in Table 5.

DISCUSSION OF RESULTS

The results of eight trials showed that a slight decrease occurred when the milk was clarified at 55°F. In four trials in which the



No. 1 No. 2 No. 3 No. 4

PLATE 1

VOLUME OF CREAM RISING ON RAW MILK AND ON MILK MADE FROM VISCOLIZED CREAM AND UNVISCOLIZED SKIM MILK

Milk pasteurized at 142°F. for thirty minutes
No. 1. Milk made from viscolized cream, 4 per cent fat
No. 2. Raw milk, 4 per cent fat
No. 3. Raw milk, 4 per cent fat
No. 4. Milk made from viscolized cream, 4 per cent fat

milk was heated to 90°F. before clarification there was no decrease in creaming ability. In three out of four trials there was no decrease in the volume of cream when the milk was heated to 90°F. after clarification. It would seem logical to conclude that milk heated to pasteurization temperature after clarification would not have its creaming ability lessened due to the clarifier.

Pumping milk while cold did not lessen its creaming ability. The average of seven trials in which hot milk was pumped showed but a small loss.

Hot milk subjected to agitation showed a gradual loss in creaming ability. The loss was very small for the first two hours, but after that it amounted to 20 to 65 per cent.

To prevent loss in creaming ability of pasteurized milk, it should be cooled as quickly as possible with the least possible agitation. When milk is cooled in the pasteurizer considerable loss occurs, the amount depending on the type of pasteurizer, and amount of agitation to which the milk is subjected.

The fundamental cause of variation in creaming ability of milk will possibly be found in the milk serum, and not the butterfat, as has long been the opinion.

DAIRY NOTES

The Western Dairy Instructors Association has been authorized to form a Western Section of the American Dairy Science Association, with W. M. Regan of California as president.

Agricultural bacteriology in Italy, France and England as seen by a tourist.[1]

R. S. Breed, New York Agricultural Experiment Station, Geneva, N. Y.

This paper is a brief review of the impressions gained by a recent visit to a series of European institutions engaged in research in agricultural and general bacteriology. In Italy, these included the three agricultural universities known as the Technical Higher Schools of Agriculture at Portici (near Naples), Perugia (Central Italy) and Milan Northern Italy). Visits were also made to the International Institute of Agriculture at Rome, the Experiment Station for Cheese Making at Lodi near Milan, the Animal Husbandry School at Reggio-Emilia and the Agricultural Experiment Station at Modena. As these are representative institutions out of a large number of institutions for agricultural education and research, as the work done is of high grade, is apparently in a position to secure reasonable support, and as a fine spirit of work seemed to pervade all of them, the impression gained was that the Italian group of workers would continue to contribute more than their full share to the sum of human knowledge gained by study in this field. The barrier of language between Italy and the U. S. A. is a serious one and has led Americans to undervalue the type of work that has been done in this progressive country.

A much longer stay in France showed that while very fine work was being done at a few institutions, there was no such extensive series of institutions doing high grade work in agricultural bacteriology as in Italy. Just as in the field of medical bacteriology, the Pasteur Institute takes the lead among French institutions for research in agricul-

[1] Read before the Central New York Branch of the Society of American Bacteriologists, Ithaca, N. Y., October 27, 1923.

tural bacteriology. At the Institute in Paris, the work of Professor Mazé in bacteriology and plant physiology is noteworthy, while the most interesting new development at the Institute is the establishment of a laboratory of soil bacteriology at Brie-Comte-Robert under the leadership of Professor A. Winogradsky. A visit to this newly-equipped laboratory, thirty miles to the east of Paris showed him to be very happy to be again at work after the changes brought about by the war and especially happy to be again working at the Institute to which Pasteur himself had invited him many years before. Especially noteworthy, also, is the work being done at the National Institute of Agronomy in Paris. Visits were also made to the National School of Agriculture at Grignon, and to the Veterinary Colleges at Lyon and at Alfort. In general, research work in agricultural bacteriology seemed to be suffering from a lack of adequate national support and there seemed little indication of the vigorous activity that might have been expected in a reconstruction period. French energies seem to be almost completely occupied in the reconstruction of the devastated regions and in related problems.

In England the chief centers of interest to agricultural bacteriologists are to be found at Rothamstead (soil work) and at the newly-organized National Institute for Dairy Research at Reading. The term newly-organized may be used, for although this institute was founded in 1910 under the directorship of Dr. Stenbouse Williams, the war so prevented its development that it is only now moving into its well-equipped and permanent quarters at Shinfield near Reading. A visit was also made to a newly organized secondary school of agriculture, the Cannington Court Farm Institute near Bridgwater in Somerset County, and to the Institute for Research in Agricultural Economics at Oxford. In this brief visit to England, the impression gained was one of vigorous activity and interest. This has firm foundation in the acute realization of the need for the development of English agriculture that has been brought home by the war. Better financial support seemed to be forthcoming, which, with an available supply of well trained workers, promised much for the future. A good indication of the lively interest in progress along dairy lines is to be found in the fact that England sent the largest delegation of any country to the World's Dairy Congress.

Advanced registry news reports. G. C. WHITE, Connecticut Agricultural College, Chairman of the Breed Relations Committee.

Several states have been issuing a condensed monthly report of cows under test for some time. These reports go chiefly to the owners of herds under test, the local farm press, county agents and extension specialists, test supervisors, and to the offices of the various breed associations.

The breed associations officials are interested in these reports and some of them make some use of this information. For this reason, more than a year ago, Mr. Baker of the American Jersey Cattle Club expressed a desire to see these reports appear in uniform tables.

As we have been urging the breed associations to place their advanced registry systems upon a uniform basis, the Breed Relations Committee of the Official Testing Section of the American Dairy Science Association feel that Mr. Baker's wish is most reasonable. The fact that some states make exchanges of these reports is another good reason for having them uniform. Accordingly, the Committee recommended a form for this purpose at the 1922 meeting, but this form has not as yet become widely disseminated. In order to get this before the state superintendents, this present statement is prepared.

Since January, 1923, the Connecticut Agricultural College has been issuing monthly reports, following the plan outlined by the Committee. A brief outline of the September report is submitted herewith:

[*First page*]

THE CONNECTICUT AGRICULTURAL COLLEGE A. R. NEWS

Vol. 1, No. 9 Department of Dairy Husbandry

For month of September, 1923. Storrs, Conn., October 15

Brief summary of the Honor List, giving number of cows qualified, total number of cows tested, number of breeders on Honor List and total number of breeders testing.

Brief note concerning National Dairy Show winnings of Connecticut Jersey and Holstein state herds.

List of completed records coming up to certain minimum records.

New state records.

[*Second page*]

CLASS	BREED	COW'S NAME AND NO.	OWNER	MONTH OF LACTATION	PRODUCTION FOR 2 DAYS		
					Milk	Fat	Fat
					pounds	*per cent*	*pounds*
S3	G	Anesthesia Faith of Hillstead 114354	Riddle	3	91.2	5.56	5.073
M	G	Nina II of Greenway 57920	Greenway	4	104.7	4.63	4.850
M	J	Gamboge's Emma of H. F. S. 324610	Barnes	2	83.2	5.82	4.846
M	H	Blackberry Farm DeKol Buttergirl 522527	Moseley	1	127.8	3.76	4.800

This page is continued with a total of 27 cows on the list.

[*Third page*—continuation of page 2]

[*Fourth page*]

List completed. Also the list of the breeders on the Honor List giving name, address, total cows on test and total cows on the Honor List. This list identifies more completely the ownership of animals on the Honor List.

These lists are mimeographed and the pages are punched together. Placing the month, or the volume and number at the top or bottom of each page will be a convenience in helping to keep the reports together in case the pages become separated.

This "News" was started this year in Connecticut for the first time. The interest shown by the breeders and others, we feel justifies the time and expense of getting it out. It is mailed on the 15th of the month following the test period and is circulated before the information is received through any other channel. Furthermore, the breeder keeps informed concerning the progress in other breeds than his own.

The requirements for admission to the Honor List in Connecticut follow:

	lbs. fat in two days
Mature cows (5 years or over)	4.000
Four year olds	3.635
Three year olds	3.270
Two year olds	2.905

The standard of requirements will naturally vary according to the number of cows on test in the various states.

Where it is preferred to publish the lists by breeds, the animals can be so classified, retaining this same form for presentation.

Some may wish to publish the total yields for the months. This can be done with the form as presented here, but the report will probably not be ready so early if complete monthly yields are used.

It should be understood by the breeders that any errors discovered by the cattle clubs or others are subject to correction.

REVIEW OF DAIRY LITERATURE

A Review of the Fourth Edition of the Standard Methods of Milk Analysis. E. G. HASTINGS.

A number of scientific associations in this country have been active in the development of methods of analyses, both chemical and bacteriological, to be used in controlling the quality of many products. The methods may relate to the commercial value of the products or to their healthfulness. Probably foremost among these associations in the development of methods for controlling healthfulness of foods, especially water and milk, has been the American Public Health Association through its Laboratory Section.

The Association published the first edition of "Standard Methods for the Bacteriological Examination of Milk" in 1910. The second edition was issued in 1916, and the third in 1920. The fourth which is entitled "Standard Methods of Milk Analysis" since it contains both bacteriological and chemical methods was published in 1923. It includes the bacteriological methods formulated by committees of the Laboratory Section of the American Public Health Association, of the American Dairy Science Association, and of the International Association of Dairy and Milk Inspectors. Doctor R. S. Breed of the New York Experiment Station, Geneva, has acted as referee for these various committees. A large part of the credit for the development and compilation of the methods should be given to him.

The present edition consists of a paper bound pamphlet of 40 pages. The first 24 pages are devoted to the bacteriological methods. These include the macroscopic colony count (the Petri plate method) and the microscopic count of bacteria (the Breed method) both of which are official methods.

The discussion of the first method includes the composition of the medium employed, its reaction and method for the adjustment thereof. Two procedures for the preparation of preparing agar are given. The procedure to be followed in plating, incubation, and counting the plates is presented. The common sources of errors in making plate culture counts are discussed as is the manner of reporting results.

The microscopic count of bacteria is presented under the heads of apparatus required, preparation of films of dried milk, standardization of the microscope, counting, sources of errors, and reporting results.

The description also includes two provisional methods, the microscopic colony count developed by Doctor W. D. Frost of the University of Wisconsin, and the reductase test or the methylene blue reduction test as it is more commonly called.

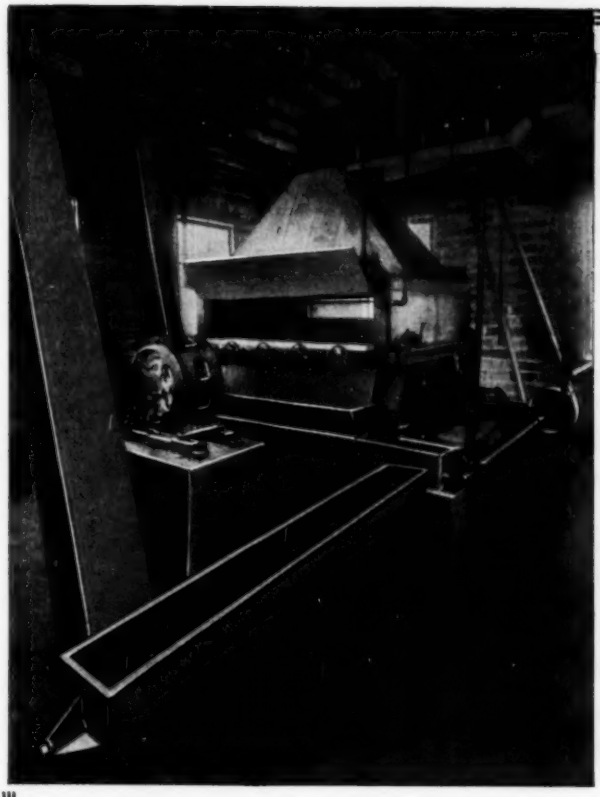
It should be recognized that each of these methods will enable the analyst to divide the milks examined into a number of grades which are differentiated by the number of bacteria in the milk. In a general way all give the same information in regard to the milks to which they are applied. On the other hand, one cannot expect that the number of bacteria found in a particular sample of milk through the use of one method will be the same as when another method is used. The number will usually be of the same order of magnitude, but now and then wide differences must be expected. This is due to the fact that the bacterial flora of milk consists of many kinds, some of which will be detected by one method and not by others. The variation is likely to become pronounced when the milk is heavily contaminated from special sources which are not constantly present on all farms. Examples of such sources are inflamed udders and milking machines, the latter giving a somewhat different type of contamination than utensils in general, when the parts are handled in certain ways.

There is no doubt but that each of the methods presented is of great value. One can best be used under a certain set of conditions, another under a different set of conditions. No one method is best. Each is good. Space does not permit a discussion of the conditions under which each of the various methods can best be used.

The sediment test is also described as is the detection of specific pathogens in milk.

The chemical methods are those adopted by the Association of Official Agricultural Chemists. They include the methods for the determination of casein, albumen, lactose, fat, added water, and for the detection of the common preservatives and coloring matters that may be added to milk.

The pamphlet can be obtained from the American Public Health Association, 370 Seventh Avenue, New York City. The cost is 40 cents per copy postpaid. Everyone interested in the control of milk should have a copy as should all engaged in the examination of milk for any purpose whatever. Teachers should also make use of the methods in their class work rather than to present other methods not officially recognized in this country.



A complete BUFLOVAK dry buttermilk plant similar to the one shown in the illustration will be shown at the

NATIONAL DAIRY SHOW

Syracuse, N. Y.

Buflovak Apparatus in the Dairy Industry

Buttermilk Drying Plants

BUFLOVAK buttermilk drying plants dry either concentrated or raw buttermilk with equal success. They are provided with storage tanks, dry material conveyors, vapor scrubbers, etc.

Vacuum Drum Dryers

for producing dry milk powders that are readily soluble and which preserve all of the original health-giving qualities and flavor of the milk.

Evaporators

BUFLOVAK Evaporators are designed especially for use in the dairy industry for producing condensed milk and semi-solid buttermilk. Careful thought has been given in designing BUFLOVAK Evaporators so that they may be easily and thoroughly cleaned.

BUFFALO FOUNDRY & MACHINE CO.

1581 Fillmore Ave., Buffalo, N. Y.

New York Office: 17 Battery Place *Chicago: 1636 Monadnock Block*

Your advertisement is being read in every State and in 25 Foreign Countries

INFORMATION FOR SUBSCRIBERS AND CONTRIBUTORS

THE JOURNAL OF DAIRY SCIENCE is issued bi-monthly, appearing in January, March, May, July, September and November. Each volume will consist of approximately 500 pages. Subscription is by the volume only and not by the year. One volume a year is issued at present.

Twenty-five reprints without covers of articles will be furnished gratis to contributors when ordered in advance. A table showing cost, with an order slip is sent with proof.

Manuscripts should be typewritten and carefully revised before submission and should be sent to Prof. J. H. Frandsen, 1401 N. 33d Street, Lincoln, Nebraska.

Correspondence concerning business matters should be addressed to WILLIAMS & WILKINS COMPANY, Publishers of Scientific Journals and Books, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

1924 Volume: Volume VII, $5.00, United States, Canada, Mexico, Cuba; $5.50, other countries. Prices are net, postpaid.

Back Volumes: Volumes I–VI, incl., $36.00, United States, Canada, Mexico Cuba; $39.00, other countries. Single numbers, $1.25. Prices are net, postpaid

Subscriptions are received:

For Argentina and Uruguay: Beutelspacher y Cia., Sarmiento 815, Buenos Aires.

For Australia: Angus & Robertson, Limited, Sydney; Stirling & Co., 317 Collins St., Melbourne.

For the British Empire, except Australia and Canada: Arthur F. Bird; Wm. Dawson & Sons, Ltd.; Dulau & Co., Ltd.; H. K. Lewis & Co.; David Nutt; J. Poole & Co.; Wheldon & Wesley, Williams & Norgate, London; James Thin, Edinburgh.

For Canada: Wm. Dawson and Sons, Ltd., 87 Queen Street, East, Toronto, Canada.

For Denmark: H. Hagerup's Boghandel, Gothersgade 30, Kobenhavn.

For France: Emile Bougault, 48 Rue des Ecoles, Paris.

For Germany: R. Friedländer & Sohn, Buchhandlung, Carlstrasse 11, Berlin NW. 6.

For Holland: Scheltema & Holkema, Rokin 74–76, Amsterdam.

For Japan and Korea: Maruzen Company, Ltd. (Maruzen-Kabushiki-Kaisha) 11 to 15 Nihonbashi Tori-Sanchome, Tokyo; Fukuoka. Osaka, Kyoto, and Sendai, Japan.

For Spain: Ruiz Hermanos, Plaza de Santa Ana, 13, Madrid.

For the United States and all other countries except as above: WILLIAMS & WILKINS COMPANY, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

Claims for copies lost in the mails must be received within thirty days (domestic), ninety days (foreign) of the date of issue. Changes of address must be received at least two weeks in advance of issue.

A COMPREHENSIVE REFERENCE BOOK ON TUBERCULOSIS

The Authorized English Edition of

TUBERCLE BACILLUS INFECTION
AND
TUBERCULOSIS IN MAN AND ANIMAL

BY

ALBERT CALMETTE

Associate Director, Pasteur Institute, Paris

Authorized Translation by

WILLARD B. SOPER, M.D. AND GEORGE H. SMITH, PH.D.

Saranac Lake, N. Y. *Yale Medical School*

SECOND EDITION

One Volume. 714 pages with 31 figures, 25 color plates. Indexed.

Everyone interested in tuberculosis should have this book at hand for constant use as a reference book. In the light of the present day knowledge it answers practically every question that may arise concerning all phases of tuberculosis work.

CONTENTS

PART ONE

The Tubercle Bacillus and Processes of Infection by it.

PART TWO

Experimental Tuberculosis and Tubercle Bacillus Infection in animals.

PART THREE

Processes of Defense and the Diagnosis of Tuberculosis Infection.

PART FOUR

Natural Immunity and Processes of Immunization Against Tuberculosis Infection.

Besredka in *Bulletin de l'Institute Pasteur:* The plan of the work and the distribution of the contents are so arranged that all information sought is immediately found. In spite of the complexity and diversity of the subjects treated in this imposing volume, one is agreeably surprised at always discovering exactly the material one is seeking. The information is exact, sober, without superfluous details.

The British Journal of Tuberculosis: In dealing with the problems of tuberculosis Calmette truly occupies first place. No one interested in tuberculosis can neglect this noteworthy work.

International Journal of Public Health: This important work must be recognized as indispensable to all who are interested in the prevention of tuberculosis.

PRICES

$8.00 in the United States, Canada, Cuba, Mexico
$8.50 in other countries

Orders from overseas must be accompanied by remittance which will be returned if book is unsatisfactory.

ORDER FORM

WILLIAMS & WILKINS COMPANY
BALTIMORE, MD.

GENTLEMEN—Kindly enter my order for _____ copy (copies) of "TUBERCLE BACILLUS INFECTION AND TUBERCULOSIS IN MAN AND ANIMAL" by Albert Calmette for which I enclose $_____. (Or) Charge to me and send invoice to cover. (Terms, 30 days.)

NAME _____

ADDRESS _____

Your advertisement is being read in every State and in 25 Foreign Countries

"Do Business with Men when the Wind is in the Northwest."

—An Old Weather Proverb.

WEATHER PROVERBS AND PARADOXES

By

WILLIAM J HUMPHREYS, Ph.D.

Meteorological Physicist, U. S. Weather Bureau

The reader will find this book both entertaining and instructive. It is so well written, and so interesting, that in reading it one absorbs much valuable and useful knowledge concerning weather predictions, almost unconsciously.

In the first part of the book the author has collected most of the important weather proverbs that have been handed down throughout the years and has separated the true and useful proverbs from the false and misleading.

No one knows, perhaps, where or when these proverbs originated, and yet many of them are useful and scientifically correct. This delightful book explains in simple terms just how and why these proverbs are applicable in predicting weather conditions.

If you are at all interested in the weather, and especially if your business or pleasure is affected by variable weather conditions, you will treasure this book as a delightful and valuable addition to your library.

ORDER YOUR COPY TODAY FROM YOUR BOOKSELLER OR FROM THE PUBLISHER

WILLIAMS & WILKINS COMPANY
Publishers of Scientific Books and Journals
BALTIMORE, MARYLAND, U. S. A.

GENTLEMEN: Kindly enter my order for _____copies of WEATHER PROVERBS AND PARADOXES by William J. Humphreys.

PRICE: { $1.50 United States, Canada, Cuba, Mexico
{ $1.75 other countries

Enclosed is $_____ in payment which I understand will be refunded if I return the book after 10 days examination.

NAME .....

ADDRESS .....

REMITTANCE MUST ACCOMPANY ORDERS FROM OVERSEAS

WP

S-2

Your advertisement is being read in every State and in 25 Foreign Countries

MARSCHALL RENNET AND COLOR

STRONG PURE

THE QUALITY OF THE MARSCHALL RENNET and COLOR has NEVER been EQUALLED

DEPENDABLE

Made in the largest and best equipped Rennet factory in America!

THE MARSCHALL DAIRY LABORATORY
MADISON. WISCONSIN

Classified Advertising

$3.00 PER INCH

Journal of Dairy Science
Mount Royal and Guilford Avenues
BALTIMORE, MD.

GUERNSEYS
THE QUALITY-QUANTITY BREED

Another aim of Guernsey breeders is to develop a high average herd production, rather than high individual records.

As a result, the average record of 1923, on cows ranging in age from less than two years up to eighteen years, was 10154.3 pounds of milk and 506.66 pounds of butter fat.

Compare this breed average with that of other breeds of dairy cattle.

For information on Guernseys write to

THE AMERICAN GUERNSEY CATTLE CLUB
Box DS-101 **PETERBORO, N. H.**

BABCOCK TESTERS

See Jour. Dairy Sci., Jan. 21, 1921, page 32

INTERNATIONAL EQUIPMENT COMPANY
352 Western Ave. (Brighton)
BOSTON, MASS.

HANSEN'S

For Prize Winners

For making butter, cheese or commercial buttermilk of delicious flavor there is no culture better than

Hansen's Lactic Ferment

It is clean and vigorous. Its continued use by prize winners is indicative of the high quality of the dairy products that you can make with it.

Ordinary buttermilk or cultured milk improves in flavor and does not whey off so easily if mixed, after cooling, with Bulgarian Buttermilk. A simple way of making Bulgarian Milk—or Yoghurt—is by using

BULGARIAN MILK CULTURE

which is an extremely active starter. It makes a delicious buttermilk and is very easy to use.

Write for literature

Chr. Hansen's Laboratory, Inc.
Little Falls, N. Y.

Your advertisement is being read in every State and in 25 Foreign Countries

DRAWINGS, ARTISTS' WORK AND ENGRAVINGS FOR MEDICAL AND SCIENTIFIC PUBLICATIONS

PUBLISHERS and authors working in the scientific field will be interested in our facilities for producing illustrations for such work. We have had years of experience in working in co-operation with some of the prominent authors and scientists of the Johns Hopkins University, which has developed in our organization an intimate knowledge of the requirements of this particular line of work. We offer you the services of the specialist in this line. Such are not available in every community, and as we are accustomed to working from written instructions, our clientele being largely at distant points, we subconsciously understand the illustrative point to emphasize, and have been very successful in satisfying our most critical patrons.

We will gladly make estimates, submit samples, and co-operate in every way possible in the production of such work.

BALTIMORE MARYLAND
ENGRAVING COMPANY

BALTIMORE, MARYLAND

Your advertisement is being read in every State and in 25 Foreign Countries

Cleanliness Defined---

Just as the term "Quality" when defined includes all the factors necessary for profitable milk and milk products, so "sanitary cleanliness" resulting from the use of

Wyandotte
Dairyman's
Cleaner and Cleanser

insures a distinctive cleanliness which protects the quality of dairy products.

Such profitable, quality-insuring, cleaning results are due to a manufacturing process which makes every pound of this material uniform, not only in action, but in purity---each barrel of "Wyandotte" is like every other---and every particle is a virile cleaning agent.

Unlike other cleaning materials it contains no non-rinsing caustic, nor will this be formed in the washing process. Because it rinses freely this cleaner leaves no film as a source of contamination.

Uniformity, purity, and its unusual rinsing qualities make "Wyandotte" economical to use.

Indian in circle

in every package.

Order from your supply house

It Cleans Clean

The J. B. Ford Co., Sole Mnfrs., Wyandotte, Mich.

Your advertisement is being read in every State and in 25 Foreign Countries

The new 10,000-lb. De Laval skims faster and cleaner

The new, large-capacity De Laval Separator is here!

It has at least 10 per cent greater *actual* hourly separating capacity than any other machine ever built--10,000 pounds of milk or 12,000 pounds of whey an hour.

It skims cleaner than any De Laval Separator ever built--and this with the milk at normal separating temperature.

Mechanically, it is the finest De Laval machine ever built.

This new No. 90 De Laval Separator is the last word of the world's most learned centrifugal engineers. It is not a new and untried product--simply another step in the steady development of centrifugal separation, which has been carried forward by De Laval engineers for more than forty years.

The new No. 90 De Laval is destined to completely revolutionize all existing ideas as to what constitutes clean skimming, low operating cost, or ease and reliability of operation. It will set a new world's standard in all these elements of separator use.

A few separator users who act at once can get immediate delivery of No. 90 De Lavals.

It will pay you to write at once for full information.

The De Laval Separator Company

New York
165 Broadway

Chicago
29 E. Madison Street

San Francisco
61 Beale Street

Sooner or later you will use a De Laval

Your advertisement is being read in every State and in 25 Foreign Countries

Your Trouble Eliminated At Last

As the result of many years persistent experimenting we are now in a position to offer to the Creamery Trade

Wagner's Precision Test Bottles

WITH PERMANENT BLACK ETCHED GRADUATION

which we guarantee to withstand acids or the strongest alkali solution commonly used in cleaning test bottles.

We guarantee this graduation never to decolorize. It enables you to read your test correctly at all times; saves your eyesight; you need not be troubled any longer with disappearing invisible graduations, a most important feature which is highly appreciated by all users. Some of the testimonials received, read:

"Your Test Bottles With Permanent Black Etched Graduation Are Worth Their Weight in Gold."

Owing to the unusually strong demand, our manufacturing resources are already taxed to the limit. We, therefore, ask you to place your orders in time.

Ask for our illustrated catalog for testing milk and its products.

ESTABLISHED 1857

Awards

Panama International Exposition

Louisiana Purchase Exposition

THE WAGNER GLASS WORKS, 695-697 E. 132nd St., New York, N.Y., U.S.A.

Inventors and Manufacturers of Scientific Glassware and Apparatus for Testing Milk and its Products

THE STANDARD FOR NEARLY FORTY YEARS

TRADE MARK

Paterson Vegetable Parchment

"Nearest to Perfection"

Nearly forty years ago we were making Vegetable Parchment.

One does not specialise for nearly forty years without coming very close to Perfection.

The Paterson Parchment Paper Co.

Passaic, New Jersey

DIFCO

BACTERIOLOGICAL REAGENTS "DIFCO-STANDARDIZED"

Recommended for use in the Bacteriological Analysis of Dairy Products

	Bacto-Peptone	
Bacto-Beef	Bacto-Agar	Bacto-Dextrose
Bacto-Beef Extract	Bacto-Gelatin	Bacto-Lactose

DEHYDRATED CULTURE MEDIA "DIFCO-STANDARDIZED"

Bacto-Nutrient Broth	Bacto-Dextrose Broth
Bacto-Nutrient Gelatine	Bacto-Lactose Broth
Bacto-Nutrient Agar 1%	Bacto-Whey Agar

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the research and development of Bacto-Peptone and Dehydrated Culture Media

DIGESTIVE FERMENTS COMPANY

DETROIT, MICHIGAN, U. S. A.